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Fossil Mammalia of the
Huerfano Formation, Eocene,
of Colorado

by
Peter Robinson

FOSSIL MAMMALIA OF THE HUERFANO
FORMATION, EOCENE, OF COLORADO

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Fossil Mammalia of the Huerfano Formation,
Eocene, of Colorado

BY
PETER ROBINSON

*University of Colorado Museum
Boulder, Colorado*

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FOSSIL MAMMALIA OF THE HUERFANO FORMATION, EOCENE, OF COLORADO

By PETER ROBINSON

ABSTRACT

Huerfano Basin is a Laramide structure developed between the Sangre de Cristo Mountains (also Laramide) and the Wet Mountains (a rejuvenated Paleozoic structure).

Huerfano beds accumulated during a period of relative inactivity in the Laramide Orogeny; fine grained sedimentary rocks derived from mountain areas outside present Huerfano park make up most of the formation. Huerfano sedimentation was brought to a close by a pulse of the Laramide Orogeny within Huerfano Park.

Huerfano beds, and their lateral equivalent, the Farisita formation, contain two fossil mammal faunas; one, the Garcia Canyon local fauna, is of Lostcabinian (late early Eocene) age; the younger fauna, the Gardner Butte local fauna, represents a substage older than Blackforkian (early middle Eocene) and younger than Lostcabinian. The Gardnerbuttean is proposed as a substage of the Wasatchian (early Eocene) stage; characterized by the presence of the following genera: *Hyracotherium*, *Coryphodon*, *Absarokius*, *Cynodontomys*, *Didymictis*, *Eotitanops*, *Diacodexis* and *Bunophorus* of early Eocene affinity, and *Metacheiromys*, *Mesonyx*, *Patriofelis*, *Oödetes*, *Palaeosyops*, *Helaletes* and *Antiacodon* of middle Eocene affinity.

FOSSIL MAMMALIA OF THE HUERFANO FORMATION, EOCENE, OF COLORADO*

PETER ROBINSON

PART I GEOLOGY

INTRODUCTION

The study of the Huerfano mammals presented here is the result of a project initiated in 1952 by Dr. George Gaylord Simpson, then Curator of Fossil Mammals and Birds at the American Museum of Natural History and now Alexander Agassiz Professor at Harvard. I started working on the project as one of his field assistants; later Dr. Simpson allowed me to study the fossil mammals.

The recent interest of the American Museum of Natural History in Huerfano Park dates from 1952, and the major concern of the museum was collection of fossil mammals from the Huerfano formation. In the same year field parties of the United States Geological Survey (R. B. Johnson and co-workers) started to map Huerfano Park as part of a larger mapping program in the Raton Basin. The U.S.G.S. interests were mainly in coal resources and secondly in oil and gas potentialities. The next year, several parties from the University of Michigan (L. I. Briggs, E. N. Goddard and students) began a long range mapping project of the entire Huerfano Park area. The University of Michigan and the American Museum of Natural History agreed to work on different aspects of the area—the museum collecting fossil mammals from the Huerfano formation and mapping the Eocene rocks and the university concentrating on other geological problems.

The occurrence of "Bridger" fossils in Huerfano beds was first noted by Hills (1889). Since the first work of Osborn (1897), faunal levels have been recognized in the Huerfano formation, a lower "Wind River" and upper "Bridger." In 1916 and 1918 Walter Granger supervised further collection of fossil vertebrates from Huerfano Park and the results of his work were discussed briefly (Granger, 1918). Small segments of the Huerfano formation's fauna have been described by specialists working on particular groups: Osborn (1919, 1929); Gilmore (1927, 1938); Denison (1938); Wheeler (1960); no one has discussed the entire fauna. Granger recognized the pre-Bridger post-Lost Cabin age of the upper faunal zone of the Huerfano formation (Letter to R. C. Hills dated 14 April 1919) but was prevented from further discussion of the material by the pressure of other work, particularly the Mongolian expeditions. The general consensus has been to equate the upper Huerfano faunal zone with the relatively barren Bridger 'A' because the Bridger 'A' occupies the appropriate stratigraphic position. Gazin informs me (oral communication) that there may not be a Bridger 'A', the particular beds being part of the Green River formation. I see no reason to change the relative position of the upper faunal zone of the Huerfano formation, but there is a semantic question about its temporal position: is it early or middle Eocene? I

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prefer to consider it the former and discuss my reasons for doing so on page 15; I recognize the essentially arbitrary nature of any placement. However, as Granger noted (letter cited) the upper Huerfano fauna contains elements nicely bridging the gap between the Lost Cabin and Black's Fork (lower Bridger) faunas. If the so-called Bridger 'A' fauna turns out to be equivalent to the upper Huerfano fauna, the Bridger 'A' may have to be removed from the early middle Eocene substage (Woodard, others, 1941).

Certain problems of the Huerfano fauna are not discussed here; these are: cranial anatomy of the Microsyopidae based on skulls of *Microsyops* and *Cynodontomys* collected from locality II and discussion of the quarry sample of *Hyracotherium* from locality VIII. M. C. McKenna is describing the Microsyopidae and D. B. Kitts will describe the *Hyracotherium* sample. A. E. Wood described the paramyid rodents in his revision of the Paramyidae and Max Hecht will describe the lizards and snakes. The Huerfano fauna includes at least 58 species of mammals belonging to 42 genera. In addition, perhaps 15-20 species of birds, reptiles, fish and molluscs have been collected, which brings the total faunal sample to approximately 75 species.

In many ways Huerfano Park is unique in having a mammal-bearing formation so intimately associated with orogeny. Certain areas of western Wyoming are similarly associated but not as fossiliferous. Because of the association of Laramide deformation and the Huerfano formation, a longer discussion of local and regional geology is included than usually is in a faunal study.

ACKNOWLEDGMENTS

Many people have helped me by criticism, by offering data or both. I am indebted to Drs. S. A. Northrup, V. C. Kelley, J. S. Findley and S. A. Wengert of the University of New Mexico for criticism of my initial efforts. Drs. L. I. Briggs, E. N. Goddard, David McCulloch, Earle Kauffman and Herbert Tischler of the University of Michigan discussed many of the Huerfano Park problems with me and gave me much data. Drs. Max Hecht and A. E. Wood identified reptiles and rodents, respectively, from the Huerfano formation. Mr. G. T. Benson of Yale University discussed problems of southern Colorado geology with me and showed me the geology of the Stonewall area. Dr. K. M. Waage of Yale has criticized the manuscript and has discussed problems of Mesozoic stratigraphy.

The staff of the American Museum of Natural History have been very helpful to me, particularly Drs. E. H. Colbert, Bobb Schaeffer, and M. C. McKenna, Mrs. Rachel H. Nichols and Messrs. Louis Monaco, George O. Whitaker and Joseph A. Nocera. Peter Rona, Ruben Aguirre and Peter Hilgendorf helped collect fossils in Huerfano Park.

I have discussed problems of Huerfano Park geology or paleontology with Mr. Ross B. Johnson of the United States Geological Survey, Dr. C. Lewis Gazin of the U. S. National Museum, Dr. David Kitts of the University of Oklahoma and Mr. Giles McIntyre of Columbia University.

I am extremely indebted to Drs. Joseph T. Gregory formerly of Yale, now at University of California, Berkeley, and George Gaylord Simpson of Harvard for all the help they have given me. The Society of Sigma Xi, the American Museum of Natural History and the John T. Doneghy Jr. Research Fund for Vertebrate Paleontology at Yale University have aided the study with grants for field work.

Drs. Mary R. Dawson, Glenn L. Jepsen, John H. Ostrom and Elwyn L. Simons have read the manuscript and offered welcome criticism.

GEOGRAPHY

Huerfano Park is a northwest-trending intermountain valley located between the Wet Mountains on the east and the Sangre de Cristo mountains on the west in south-central Colorado. The north boundary of Huerfano Park is the drainage divide between Huerfano River tributaries and streams flowing to the north through the Wet Mountain Valley. The south boundary is a pediment extending from the Spanish Peaks northward to the park. The Huerfano River and its tributaries drain Huerfano Park; the river runs southeastward around the southeast end of the Wet Mountains and then northeastward to the Arkansas River. Muddy Creek, the main tributary of the Huerfano River, joins it at the town of Gardner.

Several large hills are found in Huerfano Park. The northernmost is Black Mountain or Promontory Bluff. Little Sheep, Sheep, and Rough Mountains and Mount Mestas are a series of synaxial intrusives of Laramide age standing in the fold belt of the east flank of the Sangre de Cristo Mountains. Dike Mountain, The Black Hills and the Spanish Peaks represent three crossaxial intrusives that lie to the south of Huerfano Park; the Spanish Peaks are noted for the dike networks associated with them (Knopf, 1936, 1956).

Settlements in the area are: Gardner, a town of some 200 inhabitants located at the confluence of Muddy Creek and the Huerfano River; Farisita, a hamlet located at the junction of the Huerfano River and Turkey Creek, five miles southeast of Gardner; and Badito, a cluster of houses at the south end of the Wet Mountains where the Dakota sandstone plunges beneath the surface.

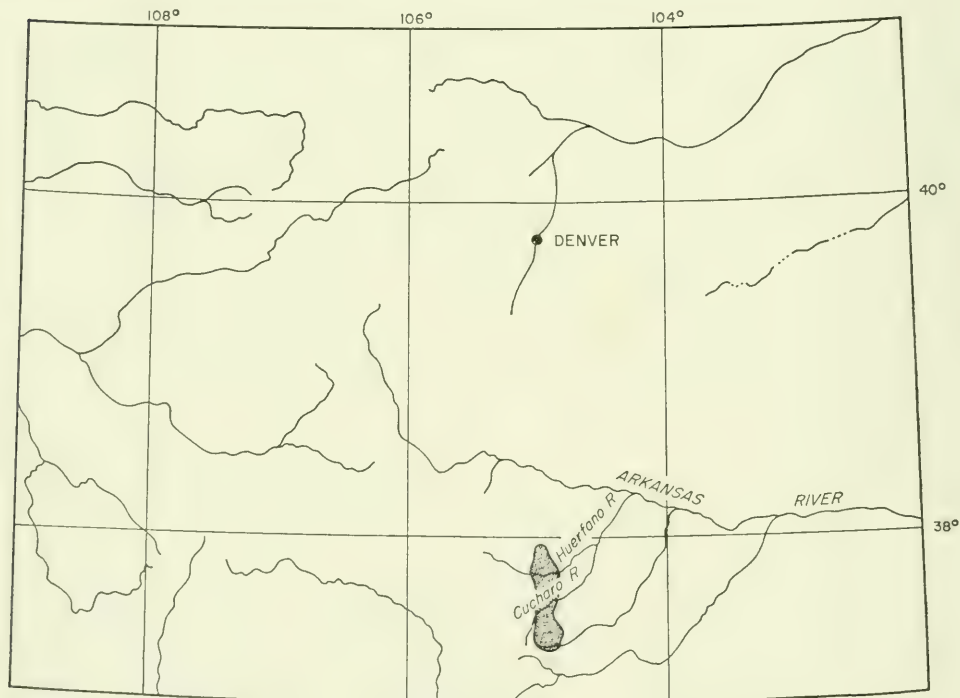


Figure 1. An index map of Colorado showing the location of Huerfano Park and the approximate area (stippled) occupied by the Huerfano and Farisita formations.

Two hamlets are found in the Huerfano Valley above Gardner: Malachite is approximately six miles upstream and Redwing is two miles farther. Eight miles up Muddy Creek from Gardner is the headquarters of the JM Ranch; Bradford, a ghost town, is approximately five miles farther up the Creek.

CENOZOIC SYSTEM

PALEOCENE SERIES

POISON CANYON FORMATION, HILLS, 1888: EMEND. 1891.

The Poison Canyon formation crops out in a band around the western flank of the Wet Mountains and in front of the foothills belt of the Sangre de Cristo Mountains and southward in the marginal area of the Raton Basin. It rests unconformably (Black Hills area) or disconformably (Archuleta Draw, Poison Canyon) upon the Pierre shale. The Poison Canyon formation underlies the Huerfano formation conformably at Black Mountain and disconformably in Poison Canyon and Archuleta Draw.

The Poison Canyon formation is composed of approximately 1300 feet of yellow to brown, massive, cross-laminated sandstone beds and drab brown or grey silty, often fissile, mudstones. The sandstone beds are resistant and often

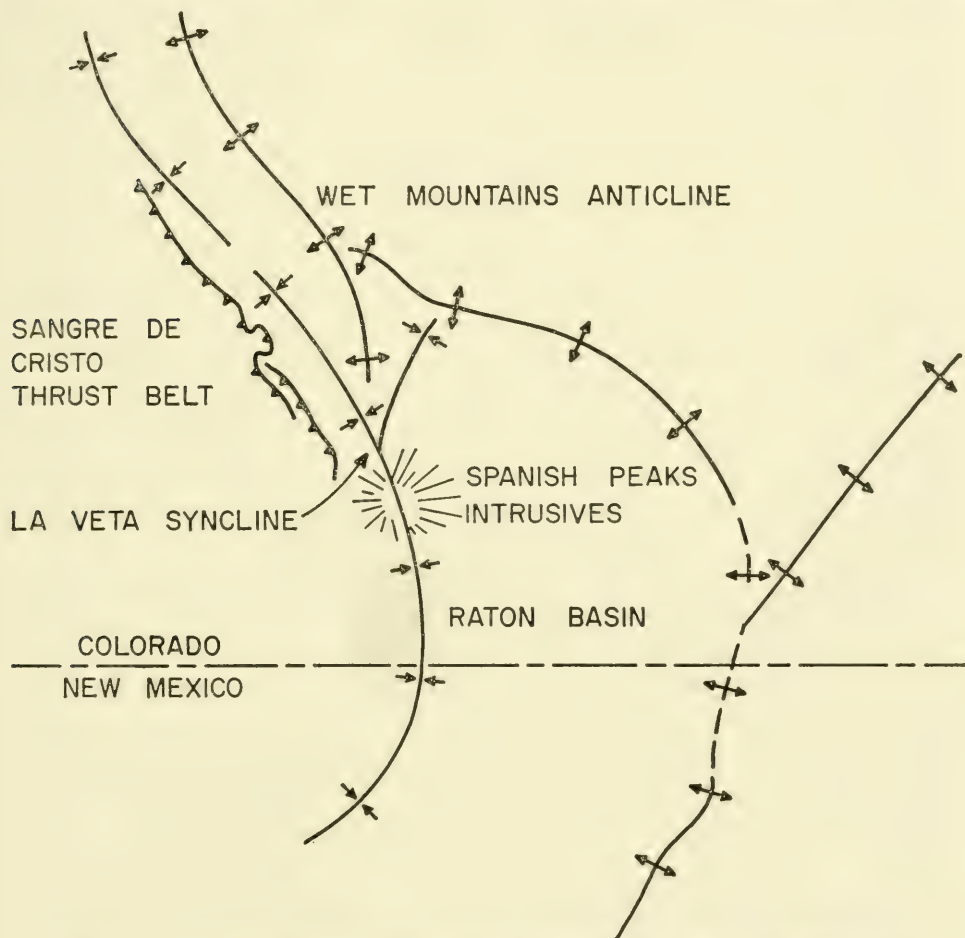


Figure 2. Tectonic map of the Raton Basin modified from John W. Gableman (1956).

form cliffs along valley sides; the mudstone beds are usually covered. Impressions of fossil leaves are common in the shale beds; Briggs and Goddard (1956) report a tropical flora similar to that of the Denver formation from beds 80 feet below the top of the formation at the type locality.

The unconformity below the Poison Canyon formation in Huerfano Park indicates a depositional break and erosion prior to deposition of the formation. Farther south, in the Raton Mesa region, Johnson and Wood (1956a, b) have shown that the basal beds of the Poison Canyon formation intertongue with the upper beds of the Raton formation in that area. The Trinidad sandstone and the Vermejo formation of late Cretaceous age are present between the Pierre shale and the Raton formation. Because the Poison Canyon formation rests unconformably upon the eroded Trinidad sandstone and Vermejo formation in the Black Hills area (Johnson, Wood and Harbour, 1958), these latter two formations probably extended farther north, perhaps into Huerfano Park. The Raton formation may not have extended far north of the Spanish Peaks area and therefore not into Huerfano Park. The erosion that preceded the deposition of the Poison Canyon formation is hard to estimate quantitatively. Generally the Cretaceous and younger formations are thinner in Huerfano Park due to the topography of the depositional site as well as to post-depositional erosion. As much as 500 feet of pre-Poison Canyon erosion may have occurred, but the absence of lower Laramide sediments may also be due to non-deposition. If the Trinidad sandstone and the Vermejo formation were eroded from Huerfano Park, the necessary uplift produced little structural discordance.

EOCENE SERIES

HUERFANO FORMATION, HILLS, 1888; EMEND. 1891

The Huerfano formation crops out in the center of Huerfano Park and southwards to the southern flank of the Spanish Peaks. As used here, the term Huerfano formation includes the Cuchara formation of current United States Geological Survey usage. In Huerfano Park the Huerfano formation is composed of approximately 2800 feet of pink, red, red-brown and brown silty mudstones and lenses of yellow, tan or green sandstones. The mudstones often contain concretions, which may be encrustations on fossil bone. Farther south, in the Spanish Peaks area, approximately 5000 feet of Huerfano formation is present. The percentage of sandstone increases southward; sandstone forms approximately 10 per cent of the Huerfano formation in Huerfano Park and approximately 50 per cent (Johnson, Wood and Harbour, 1958) of the formation in the Spanish Peaks area.

The lower part of the Huerfano formation in the Spanish Peaks area is poorly exposed; the upper part is mainly contact metamorphic rocks forming the major portion of the Spanish Peaks.

Fossil vertebrates are generally found in the more extensive exposures of the Huerfano formation. Since many of the fossils are small, collecting specimens may require a trained eye. Fossils are more common in mudstones than in sandstones and are more common in Huerfano Park than in the Spanish Peaks area. In Huerfano Park two lower Eocene provincial substages, Lostcabinian and Gardnerbuttean, are present. Lower Eocene fossils are present (Robinson, 1960) less than 1000 feet above the base of the formation in the Spanish Peaks area.

FARISITA FORMATION, JOHNSON AND WOOD, 1956

Johnson and Wood (1956) proposed the term Farisita formation for yellow, tan, buff, white and grey poorly indurated sandstones and silty mudstones. As

originally described, the Farisita formation was supposed to rest unconformably upon the Huerfano formation. University of Michigan investigators have discovered that the Farisita intertongues with the Huerfano formation (Briggs and Goddard, 1956). Faunal evidence indicates that both of the Huerfano faunal zones are present in the Farisita formation; Farisita beds may intertongue with Huerfano beds throughout the entire thickness of the Huerfano formation. Therefore, it seems that the published estimates of 1,000? feet (Briggs and Goddard) and 0-1200 feet (Johnson and Wood) may need revising.

Outcrops of the Farisita formation are best exposed between William's Creek and Turkey Creek, north of Gardner Butte. Similar lithology occurs as inter-beds in the Huerfano formation in the area west of William's Creek; Farisita beds crop out above Huerfano beds in Black Mountain.

Berner and Briggs (1958) state that on the basis of lithologic comparisons the source for the Farisita formation was probably the Front Ranges, especially the Wet Mountains. The streams depositing the Farisita sediments are thought to have come from the northwest, in contrast to the streams flowing from the south or southwest that deposited the Huerfano formation. It is difficult to believe that sediments derived from the Wet Mountains were deposited by streams flowing from the northwest, as the Farisita formation lies on the southwest side of the range. It seems more likely that if the Wet Mountains were the source of Farisita sediments, then the sediments came from the northern part of the range and also, perhaps, from the Front Range.

The Farisita formation is easy to distinguish from the Huerfano formation by its generally light yellow or tan color, by the lack of induration of the sandstones and by the generally greater percentage of sand in the mudstones. Moreover, fossil wood is common in the Farisita formation and rare in Huerfano beds while fossil vertebrates are scarce in Farisita beds and rather common in the Huerfano facies.

Perhaps the evidence that the Farisita and Huerfano formations interfinger through most of their thickness and that they are equivalent in age (except where the Farisita formation overlies Huerfano formation at Black Mountain) should be used as criterion for considering them one unit. The differences between the Huerfano and Farisita are striking and make the two local units mappable. The dissimilarities between the Huerfano and the Cuchara formations are not striking, except at extreme ends of the outcrop belt. The change from sandstone-poor Huerfano beds to sandstone-rich Cuchara beds is gradual; the change from pink, red and brown Huerfano mudstones to yellow and tan Farisita sandstones and mudstones is abrupt.

Fossil localities in Farisita beds are listed with those from the Huerfano beds. Both faunal levels present in Huerfano facies are present in Farisita beds; i.e. late early Eocene Lostcabinian and Gardnerbuttean provincial substages.

FACIES CHANGES

Geologists studying the rocks of the Raton Basin have given formational names to most of the facies of lower Cenozoic rocks displayed in the area. Recent work by the United States Geological Survey has demonstrated facies relationships between the Raton, Poison Canyon and Huerfano (= Cuchara) formations south of the Spanish Peaks (Johnson and Wood, 1956).

In Huerfano Park, the Huerfano formation intertongues with the Farisita formation (Briggs and Goddard, 1956) throughout most, if not all, of the thickness of the Huerfano formation. At Black Mountain Farisita beds overlie the

Huerfano beds unconformably; whether this unconformity can be traced within the Farisita facies is not known. Fossils collected from the Huerfano facies in Farisita-Huerfano intertonguing zones (Briggs and Goddard, 1956) and Farisita fossils reported on below indicate general agreement in age of the two facies. Unfortunately, no fossils have been collected from Farisita beds above the unconformity at Black Mountain.

Generally the contact between the Poison Canyon formation and the Huerfano formation is disconformable, but it is gradational at Black Mountain. The basal Huerfano beds in the northern part of Huerfano Park vary laterally from massive, cross-laminated white and pink arkosic sandstones and rufous shales into red, yellow, gray and bluish mudstones. The massive sandstones have been called Cuchara formation by Hills (1889-1891), Burbank and Goddard (1937), Johnson, Wood and Harbour (1958) and Briggs and Goddard (1956). These bright pink and white sandstones are unlike the sandstones found in the type Cuchara, which are yellow to brick red in color.

Detailed study shows that lateral changes in Huerfano beds are locally prominent. Near the head of Yellowstone Creek in Sec. 7 and 8, T28S, R69W, two

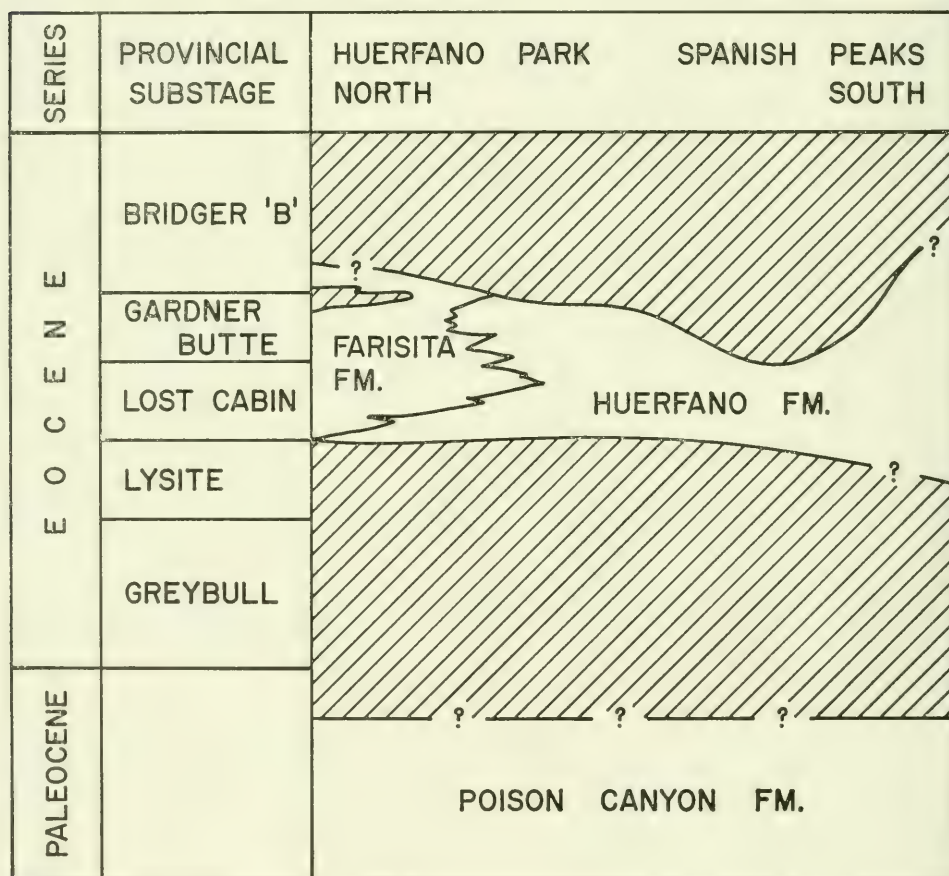


Figure 3. A chart showing the inferred stratigraphic and age relationships of the Huerfano and Farisita formations in Huerfano Park and the Spanish Peaks regions, Huerfano County, Colorado.

striking variations are present. One of these is a 50-foot unit of massive, yellow, cross-laminated, conglomeratic sandstone that extends eastward about 1 mile and then either grades into mudstones or is covered. Individual beds of sandstone may be 6-8 feet thick. On the opposite (south) side of Yellowstone Creek is a red, sandy mudstone containing much detrital mica.

Similarly, local changes in lithology are striking in the Poison Canyon and Black Mountain area. In addition to the facies changes mentioned in connection with the contact of the Poison Canyon formation and Huerfano formations, there are beds of conglomerate containing large boulders. The one unifying feature of the many local changes in Huerfano lithology is their presence at the western limit of the formation, where structural complications are common, and where local irregularities in the Eocene drainage would have been most pronounced.

Berner and Briggs (1958) state that the source of Huerfano sediment was south or southwest of the present exposures in Huerfano Park. This interpretation is compatible with the increase in percent of sandstone southward, especially in the Spanish Peaks area. The thickness of Laramide sedimentary rocks is greatest in the Spanish Peaks area (Johnson and Wood, 1956, isopach maps) indicating that subsidence was greatest there and perhaps indicating proximity to source of sediments (Culebra Range of Sangre de Cristo Mountains).

TERMINOLOGY OF THE LOWER CENOZOIC ROCK UNITS IN HUERFANO PARK

Which formation name is valid for these lower Eocene rocks, Huerfano or Cuchara? Hills' first paper (1888) used two terms for the lower Cenozoic rocks of Huerfano Park: Huerfano beds (p. 148) and Poison Canyon series (p. 152) or Poison Canyon conglomerates (p. 151). These terms applied to all three units described in his generalized section on p. 149. His section is (descending order):

"Red and yellow sandy clays and marls, sometimes shaly, alternating with yellowish, white, gray and greenish sands . . . 2000 feet. Light-red, white, brownish or variegated soft sandstones alternating with red and yellow sandy clays and marls . . . 1500 feet. Yellowish, or light-colored, soft sandstones and conglomerates with occasional beds of yellow clay or marl . . . 3500 to 4500 feet."

Hills noted the similarity of the two upper units, noting the dominance of sandstones in the middle unit. The thickness of Poison Canyon beds reported is probably due to Hills' failure to notice the anticline in Poison Canyon and therefore the repetition in strata, or may be due to his not noticing the change in dip, which decreases westward. Hills later (1889) changed his mind regarding the thicknesses of the individual units, but the total was similar. Hills revised section is (1889, p. 218):

"Marls, clays, soft shales and sands, of red, gray, yellow, green and purple colors, red predominating. 3300 feet
Pink and white massive sandstones. 300 feet
Soft sandstones and fine conglomerates of a yellowish tint, with occasional bands of yellow clay or marl . . . 3500 feet."

He noted that the last figure might be in excess.

Hills stated that the pink and white sandstones of his "middle division"

formed most of the exposures in the Cuchara Valley (1889, p. 219). No specific terms were applied to these beds. In 1891, Hills decided to apply names to his subdivisions of the lower Cenozoic beds which had been called "Huerfano beds, Huerfano series, and Poison Canyon series" all three terms being synonymous and purposely general (1891, p. 7). His terminology was (1891, p. 9):

"Huerfano series	{	Huerfano beds Cuchara beds Poison Canyon beds"
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Hills' larger unit would be a group in present usage. Hills stated that the type localities of the units are as follows: Huerfano beds—along Muddy Creek-Huerfano River divide from Mouth of Poison Canyon into the valley of Muddy Creek (1891, p. 7); Cuchara beds—Cuchara River Valley especially beds north and south of La Veta; Poison Canyon beds—Poison Canyon, an arroyo entering Muddy Creek from the southwest. However, Hills' description of the Cuchara beds was taken from the exposures near the mouth of Poison Canyon, 20-25 miles north of the type locality. At Poison Canyon, beds called Cuchara form massive pink and white arkosic sandstones of limited lateral continuity. In the La Veta area, sandstone beds of this pastel colored lithology are absent; instead dark massive, red, micaceous sandstones are present.

The term "Huerfano" beds or formation is well entrenched in the literature (works of Hills, Osborn, Burbank and Goddard) while the term Cuchara, almost as old, was not in common usage until more recently (Burbank and Goddard, Johnson and his co-workers). The type locality of the Huerfano beds is good, having approximately 2800 feet of rocks exposed. At the type locality of the Cuchara formation are 5,000 feet of poorly exposed or contact metamorphosed rock (thickness from Johnson, 1958), assuming that the Spanish Peaks can be included in Hills' "exposures . . . south of La Veta."

Few exposures of Eocene rocks are present between Yellowstone Creek and La Veta. The existing outcrops are in valley walls; the valley bottoms and the drainage divides are covered by alluvium. Robinson (1960) reported the presence of one fossil of early Eocene age in the "Cuchara" formation and noted that two others had been collected from the La Veta area. Locality VIIIa in Huerfano Park is in beds included in Cuchara formation by Johnson, Wood and Harbour (1958). *Lambdaotherium* at this locality indicates a Lostcabinian age. The 4,000 feet of rock above the known fossil from the La Veta area indicates that the Huerfano formation in that area may include beds younger than lower Eocene. Therefore, Huerfano beds in Huerfano Park and in the La Veta area are of general time equivalence.

The two areas have lithologic continuity as well. Huerfano beds overlie Poison Canyon beds in Huerfano Park, in the Spanish Peaks area and between (Johnson, Wood and Harbour, 1958). Thick sections, containing the upper beds of the Huerfano formation, are preserved in Huerfano Park and in the Spanish Peaks; only lower beds are found in the exposures from Gardner Butte southwards to La Veta (that is, in beds usually called Cuchara). One might separate the Huerfano and Cuchara formations on age criteria, considering all the beds of Lostcabinian age (Garcia Canyon local fauna) as Cuchara formation and considering the beds of Gardnerbuttean age as Huerfano formation. However, a formation, being a rock unit, is, or should be, defined on lithologic grounds.

The recent geologic map of Raton Basin and Huerfano Park by Johnson, Wood and Harbour (1958) shows the inferred contact between the Cuchara forma-

tion and Huerfano formations in the divide between Archuleta Draw and South Oak Creek. The divide is capped by a pediment, therefore critical exposures are confined to valley sides north and south of the divide.

Reasons for considering the two formations synonymous are:

- 1) The two typical lithologies occur only at extreme ends of the outcrop belt;
- 2) The two formations are general time equivalents;
- 3) The two formations occupy the same stratigraphic position (overlie the Poison Canyon formation);
- 4) Exposures in valley walls between La Veta and Huerfano Park indicate that one unit underlies the alluvium throughout most of the intervening distance.

Reasons for preferring the term Huerfano formation are:

- 1) The type section is well exposed, with exposed lower contact;
- 2) The lithology of the type section of the Cuchara formation is mostly hidden under cover or altered by contact metamorphism;
- 3) The term "Huerfano" has more distribution in geologic literature and priority (1888 vs. 1891).

Environment of Huerfano Park during the deposition of the Huerfano and Farisita formations:

The Huerfano and Farisita formations are interdigitating units of water-deposited sandstone and mudstone. The streams that deposited these bodies of sediment came from highlands in the south and southwest (Huerfano facies) or in the north (Farisita facies) (Berner and Briggs, 1958). Huerfano Park, during the Eocene, must have been a flat plain extending from the Sangre de Cristo Mountains eastward; perhaps the Wet Mountains formed its eastern limit. Most of the sediment accumulating as the Huerfano facies came from the Culebra unit of the Sangre de Cristo Mountains. At Yellowstone Creek, Poison Canyon and Black Mountain, the Crestone-Blanca unit contributed sediment.

The Farisita facies is derived from a "Front Range," possibly the Wet Mountains, (Berner and Briggs, 1958). The Farisita streams were either more competent or had less fine material to transport than Huerfano streams did, as the Farisita facies generally has a greater percentage of coarse material. The abundance of coarse material may also reflect a closer source.

Huerfano rocks are generally red, red-brown, brown or pink, possibly indicating a source area with an annual rainfall of some 40 inches and a warm climate in well-drained areas (Dunbar and Rodgers, 1957, p. 210). In contrast to the Huerfano rocks, Farisita rocks are tan, buff or yellow. The significance of the color change caused by a change from ferric oxide to ferric hydroxide is not fully known. In the Washakie and Bighorn basins similar color changes occur in Eocene rocks (Van Houten, 1944, p. 188-191, 195-199). In both examples the yellow facies (Green River and Tatman formations) are lake deposits whereas the red facies (Knight and Willwood formations) are flood plain deposits. Perhaps the color change (therefore mineral change) is due to conditions in the provenance, but perhaps the change reflects depositional environment as well.

If we assume that the environments of the source areas of Huerfano and Farisita sediments were the same, and were such that red soils were forming, then the difference between present colors of the Farisita and Huerfano formations is due to the effect of depositional or post-depositional environments upon the red sediments. The preservation of the red color in the Huerfano sediments suggests that the conditions of deposition of the sediments were similar to the conditions

of formation of them. The predominance of ferric hydroxide ("limonite") as a coloring agent of the Farisita facies suggests that the area was less well drained than the Huerfano area, since ferric oxide would probably be preserved in a well drained area (it forms in well drained areas, Dunbar and Rodgers, 1957, p. 210). Drainage in the Farisita formation area was poor enough to inhibit the destruction of much of the organic material by soil bacteria, because plant fragments are preserved in the Farisita formation.

If we assume that the differences now shown in the color of the Farisita and Huerfano formations are due to differences in the climate in the respective source areas, then depositional conditions must have been good for preserving the differences.

As in most geologic problems, the answer is probably that both differences in the provenance and in the depositional sites control the present color (therefore iron mineral content) of the beds. Certainly the fact that Berner and Briggs (1958) have been able to differentiate source areas for the Huerfano and Farisita beds by studies of the cross-lamination indicates that a different mineralogy in the source areas could affect the resulting sediments. I think that the Farisita formation accumulated in a wetter environment than the Huerfano formation did, perhaps in perennial or annual swamps.

The possible presence of swampy or periodically swampy land to the east of a flood plain gives rise to speculation about the nature of the areas east of Huerfano Park, areas in which no supporting evidence to hypotheses about them is likely to be found. Perhaps the Farisita facies is the record of a near-sea deposit. This may seem like an outrageous suggestion, but marine rocks formed the Cannonball of Paleocene age, and the possibility of occurrence of marine beds in other interior Cenozoic deposits should not be overlooked. If the early Eocene is the record of a period of relative quiet in the Laramide orogeny, it might indicate a time when a readvance of the sea could occur. As stated above, the crucial areas are barren of Eocene rocks; whether this is due to non-deposition as well as erosion is a question not likely to be answered.

Faunal evidence of environment is useful in that similar or the same species lived in Huerfano Park and in Wyoming during Eocene time and presumably their ecological requirements were similar. *Lepidosteus*, and crocodiles, indicate warm climates and permanent rivers. The occurrence of presumably arboreal primates such as *Notharctus*, Anaptomorphidae and Omomyidae indicates the presence of forest areas. Large ungulates do not prove the presence of savannahs but indicate that open country might have existed. The carnivores probably do not indicate any special environment; however, *Didymictis* is a large dog-like beast and may have been a forest dweller. Other large carnivores, such as *Mesonyx*, *Oxyaena* and *Patriofelis*, were probably specialized for certain habits, such as scavenging, but we cannot deduce their habitats.

Detailed study of the lizards and snakes may prove useful for determining habitats.

Most of the faunal elements are found at Locality II indicating a definite thanatocoenose. Fish, crocodiles, ungulates and arboreal primates did not occupy the same habitat in life, but they could have been closely associated. The lack of articulated material (only snakes occur in articulation there) at Locality II adds to the evidence in favor of death association. Of all the mammals found at this locality, *Microsyops lundeliusi* most probably lived nearby. This is indicated by the abundance of this species and the relatively complete preservation of the remains, which include a skull, several pairs of jaws, and jaws with coronoid and

TABLE 1

List of the genera found in upper and lower faunal zones of the Huerfano formation and their distribution in faunal levels above and below the Huerfano faunas.

Genera	Lysite	Wasatchian		Bridgerian	
		Lost Cabin	Huerfano	Lower	Upper
<i>Peratherium</i>		x		?	x
<i>Nyctitherium</i>	?	?		x	x
<i>Talpavus</i>			x		x
<i>Scenopagus</i>	?			x	x
<i>Palaeictops</i>	x	x	x		x
<i>Cynodontomys</i>	x	x	x	x	
<i>Microsyoops</i>		x		x	x
<i>Apatemys</i>	?	?		x	x
<i>Phenacolemur</i>	x	x	x		
<i>Loveina</i>	x?	x	x		
<i>Absarokius</i>	x	x		x	
<i>Shoshonius</i>		x		x	?
<i>Notharctus</i>		x	x	x	x
<i>Stylinodon</i>		x	x	x	x
<i>Esthonyx</i>	x	x	x		
<i>Trogosus</i>		x		x	x
<i>Metacheiromys</i>				x	x
<i>Mesonyx</i>				x	x
<i>Oxyaena</i>	x	x	x		
<i>Patriofelis</i>				x	x
<i>Sinopa</i>	x	x	x	x	x
<i>Viverravus</i>	x	x	x	x	x
<i>Didymictis</i>	x	x	x	x	
<i>Vulpavus</i>	x	x		x	x
<i>Miacis</i>		x		x	x
<i>Uintacyon</i>	x	x		x	x
<i>Oödetes</i>			?	x	x
<i>Coryphodon</i>	x	x	x	x	
<i>Bathyopsis</i>		x		x	x
<i>Hyopsodus</i>	x	x	x	x	x
<i>Phenacodus</i>	x	x	x		
<i>Hyracotherium</i>	x	x	x	x	
<i>Lambdaotherium</i>		x	x		
<i>Eotitanops</i>		x	x	x	
<i>Palaeosyoops</i>				x	x
<i>Helaletes</i>				x	x
<i>Heptodon</i>	x	x	x		
<i>Hyrachyus</i>		x	x	x	x
<i>Diacodexis</i>	x	x	x	x	
<i>Bunophorus</i>	x	x	x	x	
<i>Antiacodon</i>				x	x
<i>Paramys</i>	x	x	x	x	x
<i>Thisbemys</i>		x		x	x
<i>Leptotomus</i>	x	x	x	x	x
<i>Reithroparamys</i>	x	x		x	x
<i>Microparamys</i>	x	?		x	x

TABLE 2

Mammalian species of genera of mammals common to Lostcabinian (or older) and Gardnerbuttean, or Gardnerbuttean and Blackforkian (or younger) substages

Species	Lostcabinian—	Gardnerbuttean	Blackforkian+
<i>Talpavus nitidus</i>	cf		x
<i>Nyctitherium velox</i>		cf	x
<i>Microsypops lundeliusi</i>	x	x	
<i>Notharctus numenius</i>	x	x	
<i>Trogosus grangeri</i>		x	
<i>Sinopa strenua</i>	x	cf	
<i>Viverravus gracilis</i>	x	x	x
<i>Viverravus sicarius</i>		x	x
<i>Vulpavus asiaticus</i>	x	x	
<i>Miacis parvivorus</i>		x	x
<i>Uintacyon asodes</i>	x	cf	
<i>Bathyopsis fissidens</i>	x	cf	
<i>Hyopsodus wortmani</i>	x	x	
<i>Hyopsodus walcottianus</i>	x		
<i>Hyopsodus paulus</i>		x	x
<i>Hyrachyus modestus</i>	cf	x	x

angular processes preserved. No other skeletal parts are currently referable to *Microsypops*.

Costillo Pocket (Locality VIII) is the only location where much articulated material occurs, and this is mainly *Hyracotherium*, an ubiquitous early Eocene genus.

Perhaps more information about the post-cranial skeletons of many of the mammals found in Huerfano Park would allow inferences about their habitats and therefore the habitats present in Huerfano Park.

The data on Eocene floras summarized by Dorf (1955) for other western formations can be applied to the Huerfano formation because the same animals occur there and in Wyoming. Huerfano Park was probably a low moderately flat area of tropical or subtropical climate.

FAUNAL LEVELS IN THE HUERFANO AND FARISITA FORMATIONS

Lostcabinian faunal level—characterized by the presence of *Lambdaotherium popoagicum*, *Eotitanops borealis*, *Loveina zephyri*, *Hyopsodus walcottianus*, *Cynodontomys scottianus*, *Didymictis altidens* and the following genera: *Phenacolemur*, *Esthonyx*, *Oxyaena*, *?Heptodon*, *Phenacodus*. This level is the Huerfano A of Osborn and later authors and shows close correspondence with the Lostcabinian faunal level of the type area in the Wind River Basin (Van Houten, 1945; White, 1952; Osborn, 1897).

The Lostcabinian faunal assemblage in the Huerfano formation is here named the Garcia Canyon local fauna. Garcia Canyon has produced more of the lower faunal zone fossils than any other locality.

The Lost Cabin beds of the Wind River formation are divisible into two faunal levels, the upper one characterized by the presence of *Eotitanops borealis* and *Lambdaotherium popoagicum*, and the lower one by the presence of *L. popoagicum* and the absence of *Eotitanops* (Osborn, 1929). The same two levels are probably present in the Lostcabinian beds of the Huerfano formation. The presence of *Trogosus* sp. cf. *T. latidens* in the Cathedral Bluffs Tongue (Gazin, 1952, 1962) may be evidence for a Gardnerbuttean or later age for part of the

Cathedral Bluffs tongue. *Absarokius witteri* (Morris, 1954) of the Cathedral Bluffs tongue is clearly more specialized than *A. noctivagus noctivagus* from the Wind River or *A. n. nocerae* from the upper Huerfano beds. The *Didymictis* from Cathedral Bluffs is closer to *D. altidens* than to *D. vancleveae*. The *Hexacodus* of the Cathedral Bluffs tongue is evidence for a Lostcabinian age of that locality, because its presumed descendant *Antiacodon* is present in Gardnerbuttean beds. Morris' (1954, fig. 1) localities are separated by a total of 25 miles, and their relative stratigraphic position is not indicated in his paper. He does not state from which of these localities the *Trogosus* was collected but does state the locality of the *Absarokius*.

Gazin (1962, p. 5, 16) indicates that the Dad local fauna at the top of the Hiawatha member of the Wasatch formation is early Lostcabinian. The Tipton tongue of the Green River formation separates the Hiawatha and Cathedral Bluffs members of the Wasatch formation.

Gardnerbuttean faunal level—characterized by the presence of the following species of Lostcabinian or earlier affinities: *Absarokius noctivagus* (but a distinct subspecies *A. n. nocerae*), *Cynodontomys knightensis*, *Microsypops lundeliusi*, *Shoshonius cooperi*, *Notharctus nunienus*, *Bathyosis fissidens*, *Hyopsodus wortmani*, *Paramys excavatus gardneri*; and of Blackforkian or later affinities: *Viverravus sicarius*, *Miacis parvivorus*, *Hyopsodus paulus*, *Helalestes* sp. cf. *H. nanus*, *Leptotomus grandis*. The following genera are of Lostcabinian or older affinity: *Coryphodon*, *Hyracotherium*, *Eotitanops*, *Didymictis*, *Bunophorus*, *Diacodexis*. The following genera are of Blackforkian or younger affinity: *Patriofelis*, *Oödictes*, *Mesonyx*, *Palaeosyops*, *Antiacodon*. As far as known, *Huerfanius*, new genus, is restricted to the Gardnerbuttean substage. The following species or subspecies are restricted to the Gardnerbuttean substage: *Absarokius noctivagus nocerae* (new subspecies), *Trogosus grangeri*, *Didymictis vancleveae*, *Eotitanops minimus*, *Paramys huerfanensis*, *Paramys excavatus gardneri*, *Leptotomus huerfanensis*, *Antiacodon pygmaeus huerfanensis* (new subspecies).

This faunal level is the "Huerfano B" of Osborn and later authors. The presence of *Hyracotherium*, *Coryphodon*, *Cynodontomys* and *Didymictis* especially shows its relationship to the Wasatchian stage. The occurrence of *Antiacodon*, *Scenopagus*, *Patriofelis*, *Mesonyx* and *Oödictes* shows a close relationship with the Blackforkian faunal level. Osborn (1919, 1929) correlated the upper faunal zone with the Bridger A of Matthew (1909). *Palaeosyops fontinalis* is the only fossil known to have come from the area of Bridger 'A' exposures. Recent work by C. L. Gazin (1962, p. 5) indicates that there may not be any Bridger 'A', but instead that Bridger 'B' rests on the Green River formation.

I propose to refer the assemblage of fossils found in the upper faunal zone of the Huerfano formation to the Gardner Butte local fauna and erect a new substage within the early Eocene, the Gardnerbuttean. The name is taken from Gardner Butte, a prominent local landmark located near the southeastern limit of beds containing the Gardner Butte local fauna. The Gardnerbuttean substage is located between the Lostcabinian substage of the Wasatchian stage and the Blackforkian substage of the Bridgerian (middle Eocene) stage.

H. E. Wood (1934) proposed the term Black's Fork member of the Bridger formation for the Bridger 'A' and 'B' of Matthew (1909). The faunal assemblage that defines the Blackforkian substage comes entirely from Bridger 'B' beds. Fossils that have been reported to come from Bridger 'A' may come from the Green River formation (Gazin, 1962, p. 5). The lithologic change indicates that perhaps a time lapse is present. The presence of *Palaeosyops fontinalis* in the

so-called Bridger 'A' is scant, but pertinent, evidence for a correlation of the Bridger 'A' of authors (perhaps the Laney shale member of the Green River formation, Gazin, 1962, p. 5) with the Gardner Butte local fauna of the Huerfano formation. Morris (1954, p. 199) correlated the Cathedral Bluffs tongue of the Wasatch formation in the Washakie Basin with the Bridger 'A' of the Bridger Basin. Gazin (1962, p. 18; 1959, p. 135) states that Morris' Cathedral Bluffs' fauna is of Lostcabinian age, but may be somewhat younger than the Lost Cabin beds of the Wind River formation.

DISCUSSION. Correlation of beds in different depositional basins is always a matter of opinion based on available evidence. Certain criteria are more valuable than others (Dunbar and Rodgers, 1957), but weighing the value of different units of the same criteria (in this case fossil mammals) is hazardous. I believe that large cursorial mammals are more valuable for correlative purposes than small arboreal or fossorial mammals for two reasons: 1, the large cursors are more likely to spread out and more likely to do it quickly; 2, larger animals are more likely to be preserved, or at least, are found more easily and are more likely to be collected. Rapidity of evolution has always been a criterion for determination of good taxa of correlative value. Certain of the small mammals might evolve more rapidly but not enough is known about them now to be useful in correlation. I am following criteria of standard usage in placing most reliance upon the Perissodactyla and to a slightly lesser degree upon the Pantodonta, Dinocerata, Artiodactyla and Condylarthra.

From the evidence of distribution of various mammals in the Huerfano formation and from data available in recent literature it is obvious that certain species were present in one area at earlier times than they were in other areas. *Microsyops lundeliusi* is a good example: in the Wind River formation it is associated with *Esthonyx acutidens*, *Hyracotherium vasaccense venticolum*, *Hyopsodus wortmani*, *Heptodon brownorum* and *Eotitanops* sp. (White, 1952, p. 203); in the Gardner Butte local fauna *Microsyops lundeliusi* is associated with *Eotitanops minimus*, *Palaeosyops fontinalis*, *Trogosus grangeri*, *Hyopsodus wortmani*, *Hyracotherium v. vasaccense*. In the Wind River formation *Lambdaotherium* is present at the same levels as *M. lundeliusi* even though it is absent at the type locality of *M. lundeliusi* (White, 1952). Several species occur earlier in Huerfano beds than they do in known deposits in Wyoming: *Hyopsodus paulus*, *Antiacodon pygmaeus*, *Scenopagus edenensis* are a few. The presence of two titanotheres, *E. minimus* and *P. fontinalis* in the Gardner Butte local fauna which could have evolved from the same upper Lostcabinian species, *E. borealis*, is evidence for post-Lostcabinian age of the Gardner Butte local fauna. *P. fontinalis* is the probable ancestor of the Blackforkian *P. paludosus* providing good evidence for pre-Blackforkian age of the Gardner Butte local fauna. The presence of *Hyracotherium* and *Coryphodon* and the absence of *Orohippus* is good support for a pre-Blackforkian age for the Gardner Butte local fauna. The occurrence of *Trogosus* in both the Cathedral Bluffs member of the Knight formation and the Gardner Butte local fauna in the Huerfano formation does not necessarily imply time equivalence. If the *Trogosus* locality in the Cathedral Bluffs tongue is in beds containing *Hexacodus* as well, it may indicate that *Trogosus* appeared earlier in the Washakie basin. All the elements of a faunal assemblage do not appear simultaneously.

PLIOCENE SERIES

DEVIL'S HOLE FORMATION, JOHNSON AND WOOD, 1956

The Devil's Hole formation consists of several hundred feet of water-laid tuffs.

and a few andesite flows found on the flanks of the Wet and Sangre de Cristo Mountains. Although this was one of the first units to be recognized in the area (Hills, 1888), it was among the last named (Johnson and Wood, 1956a). The age of the Devil's hole formation is ?Pliocene. This age determination is based upon horse and camel teeth found by R. C. Hills in the area between Muddy and Turkey Creeks (1889, p. 220-221). Hills did not send the fossils to O. C. Marsh for

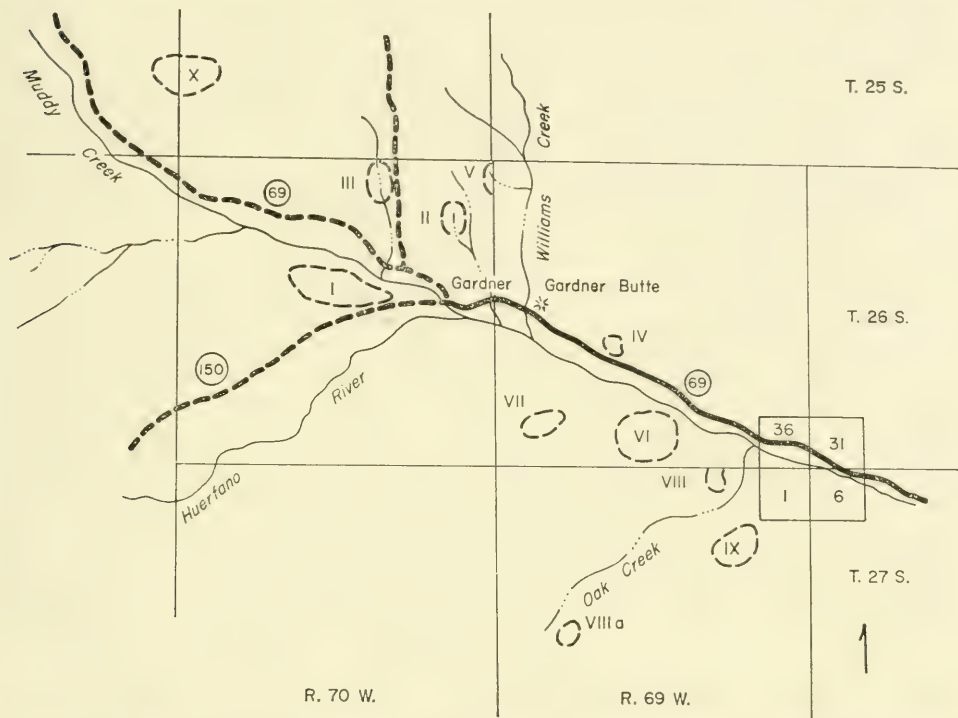


Figure 4. A sketch map of the Gardner area, Huerfano County, Colorado showing the location of the major fossil localities and geographic features.

identification so the identification is probably his own (letter to O. C. Marsh, dated 26 October, 1889). I do not know where these specimens are now stored.

STRUCTURAL GEOLOGY

General Statement. Three features determine the basic structure of Huerfano Park: The Greenhorn (Wet Mountains) Anticline, the La Veta Syncline, and the Sangre de Cristo Complex of folds and faults. Minor folds, faults and intrusions are related to the major structure.

In east-west profile, the Colorado Rockies are characterized by an eastern anticlinal mountain range (Front Range, Wet Mountains) occupying the site of the Paleozoic Colorado Mountains (King, 1959, p. 104, 105, 118); a structural and depositional basin west of the anticlinal mountains (North-Middle, South Parks; Wet Mountain Valley-Huerfano Park) and a western mountain range or ranges (Northern Sangre de Cristo, Sawatch, Mosquito, Park) which generally has major thrust fault zones and can have a thick section of late Paleozoic rocks making up much of the range (Sangre de Cristo, Mosquito). The syncline and the western

range are predominantly Laramide structures, the eastern mountain range is a rejuvenated late Paleozoic trend (King, 1959; Gableman, 1956, p. 37).

The Greenhorn Anticline. The Greenhorn Anticline (Johnson, Wood and Harbour, 1958) is a southwestern bifurcation of the Wet Mountains Anticline which plunges at Badito. The Apishapa Arch merges with the Greenhorn Anticline east of Huerfano Park and the combined structure forms the axis of the Wet Mountains. This latter structure, an en echelon extension of the Front Range, occupies the site of a late Paleozoic positive area, part of the Colorado Mountains (King, 1959, p. 118).

The Apishapa Arch extends southeastward and connects with the buried Las Animas and Sierra Grande arches (Gableman, 1956, p. 36), all structures forming part of the remnants of late Paleozoic highlands that connected the Colorado Mountains with the Oklahoma ranges (King, 1959, p. 105).

Minor faults occur at the southern end of the Wet Mountains, and an extensive thrust fault is present along the northeastern flank (Gableman, 1956); these structures do not greatly alter the anticlinal nature of the range.

The La Veta Syncline. The La Veta Syncline (Johnson, Wood and Harbour, 1958) is the structural axis of the Raton Basin, Huerfano Park and, probably, the Wet Mountain Valley (Johnson and Wood, 1956; Gableman, 1956). The Greenhorn Anticline, Apishapa Arch and Sierra Grande Arch border the syncline on the east and the Sangre de Cristo Complex borders it on the west. The axes of the eastern arch system, the La Veta Syncline and the Sangre de Cristo Complex diverge as the structures are traced southward. A small eastern prong of the La Veta Syncline, the Del Carbon Syncline, fits into the fork formed by the Greenhorn Anticline and the Apishapa Arch (Gableman, 1956). Similar interdigitations of fold axes are found in the Canon City Embayment and at the northern end of the Front Range (Blackstone, 1953). Many of the minor structures connected with the Front Range and related ranges trend northwestward (Gableman, 1956; Boos and Boos, 1957; Blackstone, 1953).

Wet Mountain Valley is apparently the uneroded northern continuation of the Raton Basin and Huerfano Park. The axis of the Wet Mountain Valley Syncline (= La Veta Syncline) extends into Pleasant Valley between the Mosquito and Sawatch Ranges (Gableman, 1956). This syncline complex extends from near Salida south to the latitude of Taos, forming one of the major, and more continuous, structural units of the Rocky Mountain region.

The Sangre de Cristo Complex. The Sangre de Cristo Complex is a series of parallel folds, thrust faults and intrusions that extend from near Salida, Chaffee County, Colorado to the vicinity of Las Vegas, New Mexico. This complex is here divided into five units: the Salida unit from Salida south to Orient, Colorado; the Crestone-Blanca unit from Orient south to the La Veta Pass area; the Culebra unit from La Veta Pass south to the Colorado-New Mexico boundary; the Mount Wheeler unit to near Taos and a southern unit composed of several small ranges (Truchas, Pecos, Cimarron, Rincon) from Taos south to Las Vegas.

The Salida unit is characterized by thrust faults on the western margin (Litsey, 1958; Gableman, 1952) which relate it to the Mosquito Mountains-Coffman Ridge uplift and not to the southern units of the complex. This unit is probably an en echelon extension of the Mosquito Mountains structure.

The Crestone-Blanca unit has been described by Burbank and Goddard (1937) and by Briggs and Goddard (1956). This unit is characterized by the flat lobate Bruff Creek Thrust and related thrusts, by a belt of folds on the eastern flank of

the Sangre de Cristo Mountains and by a series of synaxial intrusives occupying the center of the fold belt. These intrusives form the core of Little Sheep, Sheep, and Rough Mountains and Mount Mestas. The thrust faults involve a thick section of upper Paleozoic rocks (Burbank and Goddard, 1937). The Thrust plate is imbricate. Marginal, high angle reverse faults related to the thrust fault cut the Huerfano and Poison Canyon formations of early Eocene and Paleocene age.

The Culebra unit has relatively high angle thrusts with little displacement (Asquith, 1958; G. T. Benson, oral communication). This unit differs from the Crestone-Blanca unit in not having an eastern fold belt and in not having stocks; all the synaxial intrusions are dikes, sills or sheets (Benson, oral communication; Johnson, Wood and Harbour, 1958).

The Mount Wheeler unit consists of a Precambrian massif with an eastern margin buried under Cenozoic lava flows; this unit may be a structural saddle (G. T. Benson, oral communication). The southern unit consists of several ranges with thrust faults on the eastern flanks.

The western margin of the Sangre de Cristo Complex is a series of normal faults that mark the eastern boundary of the Rio Grande Trench. In most areas a Precambrian core is exposed west of the crest of the Sangre de Cristo Mountains. Recent mapping (University of Michigan parties; G. T. Benson) indicates that much of the crest of the Crestone-Blanca and Culebra units is formed by upper Paleozoic rocks.

Minor Structures. The Spanish Peaks and Dike Mountain are two intrusive stocks with radiating dike networks that occupy locations on or near to the axis of the La Veta Syncline. The Spanish Peaks are well known for their dike system and the sequence of intrusions displayed there. Petrology of Dike Mountain has not been reported on yet; it may be a single intrusion and dike network or a compound system like the Spanish Peaks. Dikes from these stocks cut the marginal structures of the Sangre de Cristo Mountains and therefore the intrusives are younger than the folding.

The cores of the Little Black Hills and the Black Hills are formed by small stocks located at the southern end of the Greenhorn Anticline (Johnson, Wood and Harbour, 1958) and may be late Laramide in age.

GEOMORPHOLOGY

Huerfano Park is the product of late Cenozoic erosion. The park contains remnants of several surfaces which produce an illusion of a flat intermountain valley. In reality at least 2,000 feet of rock has been removed from the center of the basin and perhaps more from the flanks.

Three major surfaces are present in Huerfano Park. The oldest is the present surface of the Wet Mountain Valley which can be traced southward along the flanks of the Sangre de Cristo and Wet Mountains and which caps Black Mountain (L. I. Briggs, oral communication).

The second surface slopes to the south indicating that the streams that flowed over it were south flowing, a reversal of conditions found in the old surface.

The third (young) surface is a constructional feature formed by the filling in of valleys cut into the second surface. Recent erosion has cut gullies up to 30 feet deep in parts of the young surface.

An understanding of the surfaces is necessary since most exposures of the Huerfano formation are found in valley walls exposed between the middle and the young surfaces, and mapping Cenozoic contacts is a case of finding them in adjacent gully sides. Most of the Cenozoic rock beds are hidden by one or another

of these surfaces and their related deposits.

Isolated hills such as Rough Mountain, Sheep and Little Sheep Mountains, and the Black Hills produce local irregularities in the pattern of surfaces. Subsidiary surfaces are also present indicating less important episodes in the erosional history. The young surface often merges with the middle surface near the heads of the modern arroyos; the middle surface intersects the old surface in the northern part of Huerfano Park.

At Gardner the young surface is approximately 7200 feet above sea level and the middle surface about 100 feet higher. The young surface rises to the northwest and is 7600¹ feet at the JM Ranch (eight miles up Muddy Creek from Gardner). The middle surface is about 50 feet higher than the young surface at the JM. Traced southward the middle surface decreases in elevation to Badito and then remains more or less level (in north-south profile) until the vicinity of La Veta, where it rises again; the rise is due to the presence of the Spanish Peaks. Between Badito and the Spanish Peaks the surface slopes eastward, reflecting the dominant trend in drainage. Locally, outcrops of resistant rock, such as sandstone beds or igneous dikes, produce minor fluctuations in the general trend.

GEOLOGIC HISTORY

The Laramide orogeny produced the present structural pattern, probably in several stages (Burbank and Goddard, 1937). The early Laramide geology of the Wet Mountains indicates that the area was relatively quiet. It is likely that Laramide structures in the Front Ranges are really rejuvenated late Paleozoic trends.

Sandstone lenses in the upper Pierre beds (Johnson and Wood, 1956a) in the Raton Basin record the initial movements of the Sangre de Cristo Mountains. The Trinidad sandstone is the deposit of a retreating strand (Johnson and Wood, 1956a), and the Vermejo, Raton and Poison Canyon formations record the dominance of terrestrial conditions. Several unconformities and disconformities in the Laramide sequence testify to periods of renewed erosion probably caused by renewed uplift.

Coincident with the Laramide uplift of the Sangre de Cristo Mountains was the Laramide depression of the Raton Basin. Isopach maps of the Trinidad and Vermejo formations (Johnson and Wood, 1956a) show that the axis of greatest sedimentation coincides with the axis of the La Veta Syncline. The thickest section of Laramide rocks is preserved in the Spanish Peaks area where at least 8,000 feet of terrestrial rocks occur. Laramide sediments thin out to the east and west of the axis of the La Veta Syncline and less markedly north and south of the Spanish Peaks. Data accumulated by Berner and Briggs (1958) indicate a southwestern (i.e. Culebra Range) source for most of the Huerfano formation in Huerfano Park, and the increase of sandstone in the Huerfano formation in the Spanish Peaks area agrees with the structural and other stratigraphic conclusions. The Culebra range of the Sangre de Cristo Mountains was probably the major source of Laramide sediments, and therefore possibly the most active of the units of the Sangre de Cristo Mountains during the Laramide orogeny. Unfortunately Laramide sediments derived from the Sangre de Cristo Mountains are not found south of the Raton Basin. The southward thinning of the Laramide sediments within the Raton Basin indicates that the basin probably did not extend much farther southward.

¹ Altitudes are taken as near the axis of the basin or the nearest stream as possible in order to give some impression of actual slope.

The Huerfano formation (including the Cuchara formation) is comprised of relatively fine-grained sedimentary rocks and indicates a period of relative quiet. However, coarse conglomerates with boulders several feet in diameter are present in the northwestern part of the Huerfano outcrop area (Poison Canyon and Black Mountain) indicating local streams of great competence. The proximity of these conglomerates to the Bruff Creek Thrust Fault indicates the possibility of the thrust being active during Huerfano time. If this were so, Huerfano deposition ceased with the folding and faulting present in the Black Mountain area; renewed quiet is indicated by the Farisita beds that overlie the Huerfano beds unconformably at Black Mountain.

On the other hand, the Farisita formation records uplift in the Front Ranges, probably the Wet Mountains, during the same interval. When the movement of the Bruff Creek thrust had subsided, Farisita rocks were deposited over the top of the thrust and related faults and folds, showing that active erosion (therefore uplift?) was still in progress in the Front Ranges. The lack of angular unconformities between the Pierre shale and Poison Canyon formation, and between the Poison Canyon formation and the Huerfano formation in the southeastern part of Huerfano Park shows that pre-Huerfano movements in the Wet Mountains were gentle. However, Farisita sediments overlie the Poison Canyon formation unconformably on Turkey Creek, dating the earliest strong movements of the Wet Mountains orogeny as Eocene, probably late early Eocene. Possibly the Wet Mountains uplift was never strong enough to affect beds in the center of the basin so that deposition continued uninterrupted during part or all of the first major pulse of the orogeny. The increase in amount of sediments of the Farisita facies and their spread over the western part of the basin after late Huerfano time indicates either that sedimentation from the Wet Mountains orogeny was sufficient to mask deposition from the Sangre de Cristo Mountains, that the Sangre de Cristo Mountains were not being actively eroded after late Huerfano time, or that depositional conditions had changed to favor the Farisita type lithology.

The synaxial intrusives of the Crestone-Blanca unit of the Sangre de Cristo Mountains are probably contemporaneous with the folding or faulting of the sedimentary rocks. This evidence of repeated uplift suggests that the present structure may have developed as a result of several movements. Most of the synaxial intrusives were probably emplaced in the Eocene. The involvement of Poison Canyon and Huerfano beds in the folding that occurred with the Little Sheep and Sheep Mountains intrusions indicates a post-Huerfano age for the movement. The relationship of these intrusives to the folds suggests that they are closely related in time, if not contemporaneous with folding.

The Spanish Peaks and Dike Mountain are located east of the fold belt and almost directly upon the axis of the La Veta Syncline. This sequence of intrusions of the dike system of the Spanish Peaks was established by Hills (1901) and Knopf (1936, 1956). All of the Spanish Peaks and Dike Mountain dikes are post-Huerfano and probably post-tectonic intrusion as well, because the dikes from these intrusives cut the folded belt.

Several of the igneous bodies are located well for critical age determination. Dates close to the boundary between the early and middle Eocene could be obtained from Little Sheep Mountain and from a small dike in the overturned anticline east of the JM Ranch.

The post-Farisita history of Huerfano Park is not well known, but several inferences can be made. The Devil's Hole formation of probably Pliocene age rests unconformably upon Farisita beds, leaving a sedimentary gap for most of the

middle Cenozoic; pyroclastic rocks of the Devil's Hole formation record the presence of middle or late Cenozoic vulcanism.

The Devil's Hole formation is capped by the present surface of the Wet Mountain Valley. Remnants of this surface occur on the Sangre de Cristo and Wet Mountains, and on top of Black Mountain. Younger surfaces are south-sloping, cut on Huerfano, Farisita and older rocks, showing a change from north-draining to south-draining streams and indicating that at least 2,000 feet of rock has been eroded from the central part of Huerfano Park since the cessation of Devil's Hole deposition.

PART II

PALEONTOLOGY

HUERFANO AND FARISITA FORMATION FOSSIL LOCALITIES

Eleven major and several minor localities have produced fossil mammals (see locality map). Two definite faunal levels are preserved in the Huerfano facies: a lower faunal level of Lostcabinian age preserved at localities VI, VIII, VIIIa, IX; an upper faunal level constituting the Gardner Butte local fauna at localities I, II, III, V. Both faunal levels occur in the Farisita facies: locality IV represents the Lostcabinian, and localities from one mile east to five miles north of Gardner Butte represent the Gardnerbuttean.

Locality VII is in the Huerfano facies and probably in the lower faunal zone. *Eotitanops borealis* from locality VII is a Lostcabinian species but comes from beds higher than the lowest *Lambdaotherium* specimens in both the Huerfano and Wind River formations.

Scanty evidence suggests that the fauna of the Farisita facies may differ slightly from the fauna of the Huerfano facies. Except at locality IV, Farisita fossil vertebrates are rare and poorly preserved. Faunal difference is indicated by: the relative abundance (12 specimens) of *Hyopsodus walcottianus* at locality IV and its scarcity (6 specimens) at locality VI (a relatively rich locality); the lack of *Hyopsodus wortmani* at locality IV, though it is common at most of the Huerfano facies localities; the possibility that the *Hyracotherium* at locality IV is *H. vasacienne venticolum*; and the presence of a small *Bunophorus* at the locality five miles north of Gardner Butte.

The lithologies of the Huerfano and Farisita formations are different, recording in part different source areas (Berner and Briggs, 1958). Possibly the two lithologies also record different depositional conditions. If this is true then a difference in the fauna should be expected.

The localities have the following relative positions.

Huerfano facies:			Farisita facies:	
Youngest	I	?X	Youngest	5 miles N of Gardner Butte
	I, II, III, V	?X		1 mile N of Gardner Butte
		?X		1/2 mile E of Gardner Butte
	VII	?X	Oldest	IV (2 miles east of Gardner Butte)
	VI, VIII, VIIIa			
Oldest	IX			

The exact position of most specimens from locality X is not known, but their position is probably in the upper faunal level.

Locality I. Huerfano Muddy Divide, Sec. 14, 15, 16, T26S, R70W. Most specimens are from below the white bed (unit 20 of measured section).

Cynodontomys knightensis
Microsypops lundeliusi
Absarokius noctivagus nocerae, new subspecies
Notharctus nunienus
Trogosus grangeri
Paramys excavatus gardneri
Viverravus sicarius
Didymictis vancleveae, new species
Bathyopsis sp.
Hyopsodus wortmani
Hyracotherium vasacciense vasacciense
Palaeosyops fontinalis
Helaletes sp. cf. *H. nanus*
Hyrachyus modestus

Locality II. "Fossil Creek," a small tributary arroyo to the arroyo that runs near the Roman Catholic Church in Gardner; in NW¼ Sec. 12, T26S, R70W. Most of specimens from unit 9 of measured section.

?*Peratherium* sp.
Cynodontomys knightensis
Microsypops lundeliusi
Apatemys, small species
Apatemys, large species
Absarokius noctivagus nocerae, new subspecies
Huerfanius rutherfordi, new genus and new species
Notharctus nunienus
Stylinodon sp.
Trogosus grangeri
Leptotomus huerfanensis
Leptotomus grandis
Paramys excavatus gardneri
Thisbemys nini
Paramys copei
Paramys huerfanensis
 Sciuravidae—several species
Mesonyx obtusidens
Sinopa sp. cf. *S. strenua*
Viverravus gracilis
Viverravus sicarius
Vulpavus asius
Miacis parvivorus
Uintacyon sp. cf. *U. asodes*
Oödetes herpestoides
Coryphodon sp.
Hyopsodus wortmani
Hyopsodus paulus
Hyracotherium vasacciense vasacciense
Palaeosyops fontinalis
Eotitanops minimus
Helaletes sp. cf. *H. nanus*

Hyrachyus modestus

Bunophorus sp. cf. *B. macropternus*

Antiacodon pygmaeus huerfanensis, new subspecies

Locality III. East side of arroyo in E1½ Sec. 3, T26S, R70W. The arroyo is called either Milligan's Arroyo or CCC Draw by local residents. A Mr. Milligan had a house near the mouth of this arroyo in the last decade of the Nineteenth Century; some of R. C. Hills' specimens were collected near the house.

Scenopagus priscus, new combination

Scenopagus edenensis

Nyctitherium sp. cf. *N. velox*

Cynodontomys knightensis

Microsoryops lundeliusi

Absarokius noctivagus nocerae, new subspecies

Notharctus nunienus

Trogosus grangeri

Paramys copei

Paramys huerfanensis

Paramys excavatus gardneri

Thisbemys nini

Leptotomus grandis

Sciuravidae

Mesonyx obtusidens

Patriofelis ulta

Viverravus gracilis

Oödetes herpestoides

Bathyopsis fissidens

Hyopsodus wortmani

Hyopsodus paulus

Hyracotherium vasacciense vasacciense

Antiacodon pygmaeus huerfanensis, new subspecies

Locality V. A small tributary arroyo entering William's Creek from the west about 2 miles north of the junction of William's Creek and the Huerfano River. The locality is in the E1½ Sec. 1, T26S, R70W. The fossils were collected from a red-to-pink mudstone which may be correlative with unit 9 of the locality II section. Locality V is separated from locality II by a small pediment-capped divide.

Microsoryops lundeliusi

Notharctus nunienus

Trogosus grangeri

Paramys excavatus gardneri

Viverravus gracilis

Hyopsodus wortmani

Hyracotherium vasacciense vasacciense

Palaeosyops fontinalis

Hyrachyus modestus

Locality VII. An arroyo entering the Huerfano River from the south in Sec. 29, T26S, R69W. The fossil-bearing exposures are in the NE¼ Sec. 31 and the NW¼ Sec. 32 of the same township. Granger called this arroyo "Apodock Gulch," but the apparent locality of Apodaca Gulch is Sec. 33 and Sec. 28 of the same township. This latter location is the next arroyo northwest of Garcia Cañon and is part of Locality VI of this report. This locality is probably high in Lower faunal zone.

Loveina zephyri

Paramys copei

Viverravus gracilis

Eotitanops borealis

SCATTERED LOCALITIES IN THE UPPER FAUNAL ZONE

Locality of University of Michigan. Center of Sec. 31, T25S, R69W, from Huerfano facies in zone of intertonguing between the Huerfano and Farisita formations.

Hyopsodus wortmani

Eotitanops minimus

Locality SE $\frac{1}{4}$ Sec. 26, T25S, R70W. Huerfano facies in zone of intertonguing of Huerfano and Farisita formations.

Rodent

R. C. Hills' localities. R. C. Hills collected fossil mammals from several localities which I have not been able to relocate. His localities which have been relocated are included in the American Museum locality numbers. Most of Hills' Huerfano specimens are in Yale Peabody Museum. The notable exception is the type of *Trogosus hillsi* in the U. S. National Museum. Locality #5 of R. C. Hills. Upper faunal zone.

Trogosus grangeri

Palaeosyops fontinalis

Helalestes sp. cf. *H. nanus*

Near Hausero's Ranch or 1 mile south of Hausero's. Upper faunal zone.

Stylinodon sp.

Palaeosyops fontinalis

"Box Canyon" (see Osborn 1897). Upper faunal zone.

Patriofelis ulta

Locality—1 mile "a little southeast" of Gardner Butte. Upper faunal zone.

Palaeosyops fontinalis

This important locality is undoubtedly the lowest upper faunal zone locality in Huerfano Park. The locality is probably in Sec. 20, T26S, R69W, or less than 1 mile west of locality IV in the Farisita facies, and near to AMNH locality " $\frac{1}{2}$ mile east of Gardner Butte."

Locality IV. A small arroyo north of Colorado Highway 69, across the road from the small Roman Catholic cemetery about two miles east of Gardner Butte. SW $\frac{1}{4}$ Sec. 21, NW $\frac{1}{4}$ Sec. 28, T26S, R69W. The best collecting is from gray-brown mudstone that crops out in the NE part of the arroyo. The bed lacks concretions and has a "soft" texture. The bone from this locality is broken but often has an almost "recent" appearance and color. This locality is in the Farisita facies.

Cynodontomys scottianus

Viverravus gracilis

Coryphodon sp. ($\frac{1}{4}$ mi NW of other specimens, in main part of the arroyo).

Hyopsodus walcottianus (common)

Hyracotherium vasacciense ?*venticulum*

Lambdaotherium popoagicum

?*Heptodon* sp.

Bunophorus macropternus

SCATTERED LOCALITIES IN THE FARISITA FACIES

1 mile north of Gardner Butte. Sec. 17 or Sec. 18, T26S, R60W. upper faunal zone (?)

Metacheiromys sp.

5 miles north of Gardner Butte, east side of William's Creek. Probably Sec. 29, T25S, R69W.

Bunophorus macropternus

$\frac{1}{2}$ mile east of Gardner Butte; NW $\frac{1}{4}$ Sec. 20, T26S, R69W. Possibly near to Hills' locality "1 mile a little southeast of Gardner Butte." Probably upper faunal zone.

Hyracotherium vasacciense vasacciense

Locality VI. Huerfano facies. Exposures in Garcia Cañon and Apodaca Gulch Sec. 33 and Sec. 34, T26S, R69W and in Sec. 3, 4, 5, T27S, R69W. This is the best locality in the lower faunal zone beds. Most of Wortman's collection of 1897 came from here and probably from unit 13 of measured section; unit 13 has consistently produced good specimens and matches the description of the best bone-bearing layer given by Wortman to Osborn. Granger and Olsen also made good collections here.

?Diacodon or *?Palaeictops* sp.
Cynodontomys knightensis
Cynodontomys scottianus
Phenacolemur jepseni simpsoni, new subspecies
Loveina zephyri
Notharctus nunienus
Stylinodon sp.
Esthonyx acutidens
Paramys excavatus gardneri
Oxyaena sp. cf. *O. lupina*
Viverravus gracilis
Didymictis altidens
Coryphodon sp.
Hyopsodus wortmani
Hyopsodus walcottianus
Phenacodus wortmani
Hyracotherium craspedotum
Hyracotherium vasacciense vasacciense
Lambdaotherium popoagicum
Bunophorus macropternus
Diacodexis chacensis

Locality VIII. Exposures on the northeast side of Oak Creek near the road that runs from Farisita steward on the south bank of Huerfano River. Most of the specimens come from the four excavations known as "Costillo Pocket." NW $\frac{1}{4}$ Sec. 2, T27S, R69W.

Talpavus sp. cf. *T. nitidus*
Palaeictops bicuspis
Cynodontomys knightensis
Esthonyx acutidens
Leptotomus costilloi
Didymictis ?protenus
Coryphodon sp.
Hyopsodus wortmani
Hyracotherium craspedotum
Hyracotherium vasacciense vasacciense

Locality VIIIA. Exposures at the northwest end of the divide between Oak Creek and South Oak Creek, about $\frac{1}{2}$ mile south of the headquarters of the Silverstine Ranch. NW $\frac{1}{4}$ Sec. 20, T27S, R69W.

Cynodontomys knightensis
Coryphodon sp.
Hyopsodus wortmani
Lambdaotherium popoagicum

Locality IX. Archuleta Draw, the arroyo that runs between Oak and South Oak Creeks. Fossil bearing beds are in Sec. 11, T27S, R69W. The fossils came from the lower part of unit 6 of the measured section.

Coryphodon sp.

Phenacodus vortmani

Hyracotherium craspedotum

Hyracotherium vasacciense vasacciense

Locality X. Black Mountain or Promontory Bluff. Exposures along the southwest face of Black Mountain in Sec. 25, T25S, R71W and Sec. 30, T25S, R70W. The Huerfano formation at locality X is unconformably overlain by the Farisita formation and grades downward into the Poison Canyon formation. The section is complicated by faulting and the lower contact is locally hidden beneath the hanging wall of a fault. The lower beds of the Huerfano formation dip steeply or are overturned; the dips decrease higher in the section (northeastward). Complete sections of the Huerfano formation, though probably present, could not be measured due to the faulting and the lack of continuous exposures. The Huerfano formation may be thicker at locality X than at the type locality in the Poison Canyon-Huerfano River-Muddy Creek area.

Only one fossil has been collected here in recent years, a tooth of *Didymictis vanceleveae* whose stratigraphic location is noted in Section 7. Granger and Olsen collected a rodent skeleton, *Reithroparamys huerfanensis*, high in the exposures on Black Mountain and surely from beds equivalent to the upper faunal zone beds a few miles farther southeastward.

TABLE 3
Non-mammalian fauna of the Huerfano formation

	Lower faunal zone	Upper faunal zone
Mollusca		
Gastropoda, at least three species of snails	x	x
Chordata		
Osteichthyes		
Semionotoidea		
Lepidosteidae		
<i>Lepidosteus</i> sp.	x	x
Reptilia*		
Chelonia	x	x
Squamata		
Anguidae	x	
<i>Glyptosaurus hillsi</i> Gilmore		x
? <i>Peltosaurus</i> sp.	x	x
Varanidae		
<i>Saniwa</i> sp.	x	x
sp. indet.		x
Aniliidae		
<i>Coniophis carinatus</i> Hecht		x
Colubridae		
<i>Cheilophis huerfanoensis</i> Gilmore		x
Crocodylia	x	x
Aves		x

* Provisional identification of reptiles by Dr. Max Hecht.

TAXONOMY

Measurement of Specimens. Every effort has been made to be as accurate as possible in taking measurements of teeth. I must admit to a personal dislike for the use of tooth length measurements, since the manner of arrangement of most mammal teeth in the jaw does not allow for accurate tooth length determination. Isolated teeth are another matter. Many isolated M 1's and M 2's are so similar

that they cannot be located in the series. Tooth length measurements are taken either lingually or buccally depending on which seems to give the best approximation of the actual length, the approach being uniform for any given species. In a relative sense, these measurements are valid, but what I consider a tooth length another may not.

Tooth widths are more accurate measurements. However, many students measure only the maximum width of a tooth. Where only one possible part of a tooth could be a maximum width, such as across the protoconid of most lower premolars, or across the trigonid of M_1 of *Uintacyon*, maximum widths are usable measurements. However, many mammals have molars with trigonids and talonids of similar width. In one specimen of a species, the trigonid may be wider on M_1 and in another, the talonid may be wider. This is particularly true of the common genera, *Hyracotherium* and *Hyopsodus*, in which widths of $M_{1,2}$ can be greater either fore or aft. A table of maximum widths of such teeth is then a summation of a partial sample of two variables. For this reason I have included trigonid and talonid widths of lower teeth and anterior and posterior widths of upper teeth where I thought confusion could arise.

ABBREVIATIONS

Museums:

AMNH	American Museum of Natural History
USNM	United States National Museum
YPM	Yale Peabody Museum

Teeth: Subscript numbers-lower teeth,
superscript numbers-upper teeth.

I	Incisor
C	Canine
P	Premolar
DP	Deciduous premolar
M	Molar
tr	Trigonid
tal	Talonid
buc	Buccal side
ling	Lingual side

Measurements:

L	Length
W	Width
D	Depth
mm	Millimeters
ft	Feet
N	Number of Specimens
OR	Observed Range
M	Arithmetic Mean
SD	Standard Deviation
V	Coefficient of Variability

CLASS MAMMALIA
ORDER MARSUPIALIA
FAMILY DIDELPHIDAE
? *Peratherium* sp.
Plate I, figure 7

AMNH field no. 1952-328 from locality II is a broken jaw fragment with a damaged M_3 . The jaw has the inflected angular process and internal mandibular foramen of marsupials, and the preserved part of the tooth indicates that the specimen is probably *Peratherium*.

ORDER INSECTIVORA
FAMILY ERINACEIDAE
Talpavus sp. cf. *T. nitidus* Marsh, 1872
Plate I, figure 1

AMNH 55226, a fragment of a left jaw with P_4-M_3 and at least three anterior alveoli, from locality VIII is very similar to the type of *Talpavus nitidus* Marsh. The type specimen, YPM 13511, leaves some doubt regarding the specific identity of the Huerfano specimen; the difference in stratigraphic position (Lostcabinian vs. Twinbuttesian) adds to this doubt.

In 55226, the parastylid of P_4 is low and well in front of the protoconid and is placed on the midline. The heel of P_4 of 55226 consists of a simple median cusp in the posterior margin; the cusp is separated from the protoconid by a slight, externally directed groove. The same groove is present in *Centetodon pulcher* (= *Hypacodon praecursor*, YPM 13619), but it is more pronounced (McKenna and Simpson, 1959, p. 10).

Scenopagus McKenna and Simpson, 1959

McGrew (1959, p. 151) and McKenna (1960) called attention to the dissimilarity between *Talpavus nitidus* and *Nyctitherium priscum* on the one hand and *Nyctitherium velox* on the other and stated that the former two species probably did not belong in the genus *Nyctitherium* where Matthew (1909) had placed them. With only the type specimens for comparison, it would be hard to draw generic distinction between *T. nitidus* and *N. priscum*; the latter species is larger and distinct. More complete specimens show that sufficient differences exist to warrant generic separation, and that *N. priscum* and *Scenopagus edenensis* (McGrew, 1959) belong in the same genus.

The morphology of the teeth of *Scenopagus* is very similar to *Proterixoides* (Stock, 1935), and *Scenopagus* makes a logical ancestor for the Sespe genus. The differences noted between *Scenopagus* and *Proterixoides* indicate a "fattening" of the teeth in time; many Erinaceidae have robust teeth and the trend in the Eocene forms is probably normal.

The premolar teeth of *Scenopagus* are aligned on a different axis than are the molar teeth (See Plate III, figure 5). This may indicate that *Scenopagus* was one of the "narrow-snouted" erinaceids.

The anterior root of P_2 is preserved and is directed ventroposteriorly, indicating some crowding of the premolar tooth roots and the possibility of a procumbent incisor of the *Proterixoides* type.

Scenopagus priscus (Marsh, 1872) new combination
Plate I, figure 3

AMNH 55156 from locality III is referable to *Scenopagus priscus*. The Huerfano specimen is about 25 per cent smaller than a referred specimen, YPM 14610-lb, from the Bridger formation but is similar in size to AMNH 11488 also from Bridger beds. Matthew (1909, plate 50, figure 7) referred the latter specimens to *Nyctitherium* (= *Talpavus*) *nitidus*.

The heel of the P_4 of AMNH 55156 is narrower than the trigonid; in Bridger specimens the heel of P_4 is wider.

TABLE 4
Measurements (in Millimeters) of lower teeth of *Scenopagus*

Specimen no.	P ₄		M ₁		M ₂		M ₃		M ₁₋₃		M ₃ Depth jaw
	L	W	L	W- trigonid talonid	L	W- trigonid talonid	L	W- trigonid talonid	L	W- trigonid talonid	
YPM 13610-1b	1.7	1.1	1.9	1.5	1.7	1.4	—	—	—	—	—
14939	—	—	1.9	1.4	1.8	1.5	—	—	—	—	—
15309—type; <i>S. priscus</i>	—	—	—	—	1.7	1.5	—	—	—	—	—
13610-1a	1.6	1.1	—	—	—	—	—	—	—	—	—
AMNH 55156	1.2	0.9	1.4	1.2	—	—	—	—	—	—	—
11488	—	—	—	—	1.4	1.0	1.5	1.0	—	0.8	—
55685 (from McGrew 1959)— type: <i>S.</i> <i>edenensis</i>	—	—	2.4	1.9	2.4	1.9	2.5	1.8	7.1	1.3	3.8
17483	2.1	1.5	2.6	1.9	2.6	2.1	2.5	1.9	7.3	1.5	3.7
YPM 13612-1	—	—	—	—	—	—	2.5	1.6	—	1.4	3.7
14932	—	—	—	—	2.5	2.0	—	—	—	—	—
14934	—	—	—	1.7	2.5	1.9	—	—	—	—	—
AMNH 11428	—	—	2.0	1.6	2.1	1.7	—	—	—	—	—

Scenopagus edenensis (McGrew, 1959)

Plate III, figures 4-5

Scenopagus edenensis is represented by one specimen, AMNH 17483, a jaw fragment with P_4 - M_3 from locality III. The P_4 has a small, low paraconid antero-lingual to the protoconid and lingual of the midline.

Measurements of *S. priscus* and *S. edenensis* specimens known to me are listed in Table 4.

FAMILY LEPTICTIDAE

Palaeictops bicuspis (Cope, 1880)

Plate I, figure 2

Palaeictops bicuspis is represented by a single specimen, AMNH 55271, a left M_3 , from locality VIII (Costillo Pocket). The paraconid is small and located on the midline of the tooth as in other leptictids.

Diacodon or *Palaeictops* sp.

Two lower jaws, some upper teeth, and other skeletal parts of a leptictid came from locality VI, AMNH 17555. The teeth are either broken or buried in matrix so that generic identification is impossible.

FAMILY NYCTITHERIIDAE

Nyctitherium sp. cf. *N. velox* Marsh, 1872

Plate II, figure 3

One specimen of *Nyctitherium*, AMNH 55151, a fragment of the left jaw with M_{2-3} , was collected at locality III. It does not have the pronounced external cingulum on the molars characteristic of the less worn specimens of *N. velox*, but a thin cingulum is present. The Huerfano specimen is slightly larger than the type (YPM 13510) and agrees well with several referred specimens (YPM 14936, 14935 and 14956).

McGrew (1959 p. 151) noted that *N. velox* is similar to AMNH 15103, referred by Matthew (1918 p. 605) to *N. celatum* but that the external cingulum is lacking in the latter species. *N. serotinum* from Bridger B is very similar to *N. velox* but it is smaller and lacks the external cingulum.

All of the Yale specimens of *N. velox* come from upper Bridger localities and two of the three specimens of *N. serotinum* come from the lower Bridger beds (Grizzly Buttes) and one specimen, YPM 13621, comes from a locality, Twin Buttes, that could have either upper or lower Bridger fossils (*vide* Gazin, oral communication). The external cingulum on the molars of the upper Bridger *Nyctitherium* may represent specialization. The Tabernacle Butte *N. velox* is probably late Bridgerian (McGrew, 1959, p. 125). The Huerfano *Nyctitherium* certainly is older than early Bridgerian but does have the cingulum. Perhaps the occurrence of a cingulum is variable.

ORDER PRIMATES

FAMILY NOTHARCTIDAE (sensu Gazin, 1958)

Notharctus nunienus (Cope, 1881)

Plate VIII, figure 3

MATERIAL. Locality I: AMNH 17020; Locality II: AMNH 17479, 17478, 17481, 17494, 55157, 55158, 55159, 55160, 55772, 55228; Locality III: AMNH 17477, 17480; Locality V: AMNH 17492; Locality VI: AMNH 17459, 17550, 55224.

Notharctus nunienus occurs in both faunal zones of the Huerfano formation. Three specimens have come from locality VI, lower faunal zone; fourteen specimens have come from localities I, II, III, and V, upper faunal zone. The two samples show little difference.

One specimen from locality II, AMNH 55157, has nearly all teeth preserved. The first upper incisor is wide (Gregory, 1920, p. 153); the crown is curved. The two lower incisors are small and occlude with I^1 ; I^2 is caniniform and occludes between the lower canine and I_2 .

AMNH 17478, from locality II, is large for *N. nunienus* but resembles the other specimens and has been included in the statistics for the upper faunal zone sample.

Notharctus increased in size during the middle Eocene (Robinson, 1957; Gazin, 1958). *N. nunienus* is smaller than the Bridger *Notharctus* and also smaller than *N. venticolus* from the Lost Cabin fauna of Wyoming (Granger and Gregory, 1917, p. 843). Measurements of lower teeth indicate that the upper Huerfano population was composed of animals whose mean size was slightly larger than that of the lower Huerfano *Notharctus*. The sample from the lower faunal zone is too meager for reliable analysis, but the pertinent data are:

	Lower faunal zone		Upper faunal zone	
	N	M	N	M
Length M ₂	3	5.00mm	11	5.37mm

This illustrates the trend for closely related populations of *Notharctus* to increase in size in time.

TABLE 5

Measurements (in Millimeters) of lower teeth of *Notharctus nunienus* from the Huerfano formation

Variate		N	Upper zone sample				Lower zone sample		
			OR	M	SD	V	N	OR	M
P ₃	Length	3	2.7-3.6	3.27	—	—	1		3.8
	Width	3	1.8-2.5	2.27	—	—	—		—
P ₄	Length	8	3.6-4.7	4.11	0.44	10.71	1		4.0
	Width	8	2.4-3.7	3.09	0.33	10.68	1		3.4
M ₁	Length	8	4.6-5.5	5.06	0.38	7.51	1		4.4
	Width trigonid	8	3.3-3.9	3.55	0.21	5.92	1		3.3
	Width talonid	8	3.8-4.6	4.04	0.30	7.43	1		3.8
M ₂	Length	11	5.0-6.4	5.36	0.44	8.21	3	4.7-5.3	5.00
	Width trigonid	11	3.5-4.5	4.02	0.26	6.47	3	4.0-4.7	4.27
	Width talonid	11	4.0-5.1	4.33	0.25	5.77	3	4.0-4.9	4.40
M ₃	Length	7	5.5-7.2	6.16	0.61	9.90	2	6.1-6.3	6.20
	Width trigonid	7	3.0-4.1	3.73	0.37	9.92	1		4.1
	Width talonid	8	3.1-3.8	3.55	0.30	8.45	1		3.8

FAMILY OMOMYIDAE (sensu Gazin, 1958)

Loveina zephyri Simpson, 1940

Plate II, figure 2

Two specimens, AMNH 17554 from locality VI and AMNH 55219 from locality VII, are referred to *Loveina zephyri*. The M₁ of No. 17554 resembles the type, AMNH 32517, closely. The paraconid of P₄ of the type is located more internally than in the Huerfano specimens. This, however, could be normal variation within the species.

Measurements (in Millimeters) of *Loveina zephyri* are:

	17554	55219
Length P ₄	2.0	1.9
Width P ₄	1.6	1.7
Length M ₁	2.1	—
Width trigonid M ₁	1.6	—
Width talonid M ₁	1.9	—
Length M ₂	2.1	—
Width trigonid M ₂	1.7	—
Width talonid M ₂	1.8	—

Shoshonius cooperi (Granger, 1910)

Plate III, figure 3

One specimen, AMNH 55153, from locality II, is referable to *Shoshonius cooperi*. The three lower molars are preserved, and nothing can be inferred about the still unknown premolars of this species. The external cingulum on the molars is more pronounced than in the referred specimen AMNH 14665 (Matthew, 1915c, p. 455).

Measurements (in Millimeters) of AMNH 55153 are:

	Length	Width trigonid	Width talonid
M ₁	2.4	1.9	1.9
M ₂	2.3	1.6	2.1
M ₃	2.8	1.7	1.8

FAMILY ANAPTOMORPHIDAE (sensu Gazin, 1958)

Absarokius noctivagus nocerae new subspecies²

Plate II, figure 1

TYPE. AMNH 55215, a fragment of left jaw with two anterior alveoli and P₂-M₃. Another specimen, AMNH 55270, is a fragment of the right jaw with P₃-M₂; 55270 is associated with AMNH 55215 and may be from the same individual.

HYPODGM. Type and AMNH 55217, 55218, 55152, 55154, 55155, 55270 and 55292.

HORIZON AND LOCALITY. Upper faunal zone, Huerfano formation. Type and nos. 55270, 55292 from locality II; no. 55218 from locality I; nos. 55217, 55152, 55154, 55155 from locality III.

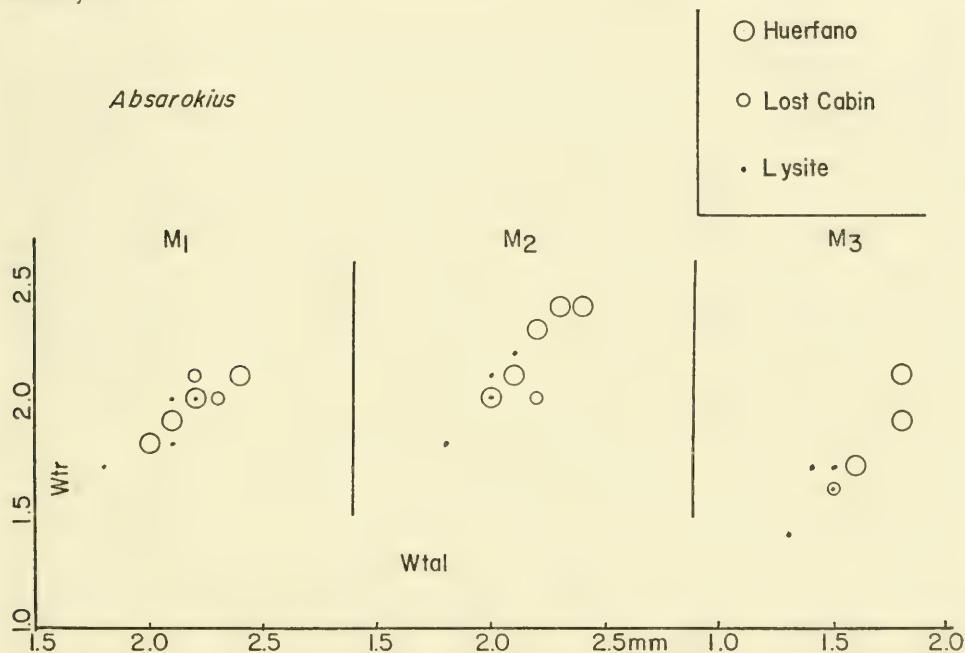


Figure 5. A scatter diagram comparison of widths of trigonids (Wtr) and talonids (Wtal) of lower molars of *Absarokius* from the Lysite, Lost Cabin and Huerfano beds.

DIAGNOSIS. M₂ averages larger size than M₂ of *A. n. noctivagus*. M₃ larger than M₃ of *A. n. noctivagus*. *A. noctivagus nocerae* is smaller than *A. witteri*.

² This subspecies is named in honor of Mr. Joseph Nocera of the American Museum of Natural History who collected the type specimen.

DISCUSSION. *A. noctivagus nocerae* is distinctly larger than *A. noctivagus noctivagus* from the Lost Cabin member of the Wind River formation. M_1 of *A. noctivagus nocerae* is about the same size as the Lost Cabin subspecies. The M_2 of *A. n. nocerae* is generally larger but the size ranges of the two subspecies overlap. M_3 is always larger in the Huerfano subspecies. A gradual increase in size in time is noted for M_2 and M_3 of *Absarokius* (figure 8, 9). *A. witteri* (Morris, 1954) from the Cathedral Bluffs tongue of the Wasatch formation is a large form that is probably not closely related to this subspecies.

The number of teeth in the jaw of *Absarokius* has been a matter of doubt. Matthew (1915c, p. 465) decided that there were only two teeth in front of P_2 and gave 1.1.3.3. as the lower dental formula. Morris (1954, p. 200) states that four or five alveoli are present in front of P_3 in *A. abbotti*, AMNH 14673; the alveoli are actually in front of P_4 . AMNH 55215, the type of *A. noctivagus nocerae*, has two alveoli in front of P_2 . P_2 is single-rooted and P_3 is double rooted. The type specimens of *A. n. noctivagus* and *A.*

TABLE 6
Measurements (in Millimeters) of lower teeth of *Absarokius noctivagus nocerae*
new subspecies and *A. n. noctivagus*

AMNH no.		<i>A. n. nocerae</i>					<i>A. n. noctivagus</i>	
		55215 type	55270	55218	55217	55152	15601 type	15602
Variate								
P ₂	Length	1.7	—	—	—	—	—	—
	Width	1.7	—	—	—	—	—	—
P ₃	Length	1.9	1.7	—	—	1.4	2.0	—
	Width	2.0	1.8	—	—	1.4	2.0	—
P ₄	Length	2.6	2.8	2.6	—	2.5	2.2	—
	Width	2.6	2.6	2.5	—	2.5	2.6	2.6
M ₁	Length	2.3	2.3	2.4	2.5	—	2.4	2.5
	Width trigonid	1.9	1.8	2.1	2.0	—	2.1	2.0
M ₂	Width talonid	2.1	2.0	2.4	2.2	2.1	2.2	2.3
	Length	2.3	2.2	2.6	2.7	2.4	2.3	2.4
	Width trigonid	2.1	2.0	2.4	2.4	2.3	2.0	2.0
M ₃	Width talonid	2.1	2.0	2.4	2.3	2.2	2.2	2.2
	Length	2.5	—	3.2	2.8	2.7	2.4	—
	Width trigonid	1.7	—	2.1	2.1	1.9	1.6	—
	Width talonid	1.6	—	—	1.8	1.8	1.5	—

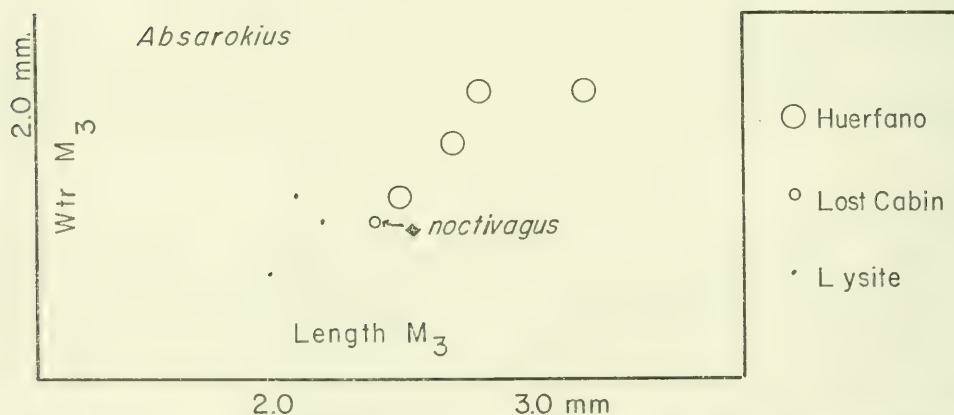


Figure 6. A scatter diagram comparison of trigonid width (Wtr) and length of M_3 of *Absarokius*.

witteri have double-rooted P_3 's (Matthew, 1915c, p. 464, fig. 36; Morris, 1954, pl. 21, fig. 2). AMNH 55215 shows that there are eight teeth, but the homologies of the two anterior ones are not certain. The alveoli of the two anterior teeth are of equal size; the first might be an incisor or a canine, the second an incisor, canine or a premolar. This question must remain unanswered until the anterior teeth are found.

A. noctivagus is the most abundant of the "tarsioid" primates in the Huerfano formation. It is not present in the lower faunal zone, but only four "tarsioids" have been found in the lower zone, so the absence of *A. noctivagus* may be due to collecting bias.

Tooth measurements are listed in Table 6.

HUERFANIUS new genus³

TYPE. *Huerfanius rutherfordi* new species, only known species of genus.

KNOWN DISTRIBUTION. Upper faunal zone, Huerfano formation.

DIAGNOSIS. Lower molar teeth (as far as known) similar in size and morphology to *Uintanius*; lower premolar teeth (as far as known) similar to but smaller than *Absarokius*, not compressed antero-posteriorly.

*Huerfanius rutherfordi*⁴ new species

Plate III, figure 1

TYPE. AMNH 55216, fragment of left jaw with P_3 - M_2 .

HYPODIGM. Type only.

LOCALITY AND DISTRIBUTION. Locality II, 2 miles north of Gardner, Huerfano County, Colorado. Upper faunal zone, Huerfano formation, uppermost lower Eocene.

DIAGNOSIS. As for the genus.

DISCUSSION. *Huerfanius rutherfordi* is similar to *Uintanius ameghini* in size and in the morphology of the molars. Its premolars are similar to those of *Absarokius*. The specimen shows a stage of premolar development intermediate to the condition in *Absarokius* and *Uintanius*; the premolars of *Huerfanius* lack the antero-posterior compression characteristic of *Uintanius*. This specimen shows that *Uintanius* might have evolved from *Absarokius*, passing through a stage similar to or represented by *Huerfanius*. The P_4 of *Uintanius*, in addition to being compressed has a paraconid, while the P_4 of *Absarokius* and *Huerfanius* lacks a paraconid.

Huerfanius is easily separable from most other anaptomorphids by its *Uintanius*-like M_2 . In *Absarokius*, *Anaptomorphus*, *Tetonius*, and *Trogolemur* the paraconid of M_2 is either absent or a small cusp close to the metaconid. *Huerfanius* and *Uintanius*, however, have prominent paraconids placed on the midline of M_2 .

Measurements (in Millimeters) of the type specimen are:

Length P_3	2.1
Width P_3	1.7
Length P_4	2.1
Width P_4	2.1
Length M_1	2.0
Width trigonid M_1	1.5
Width talonid M_1	1.6
Length M_2	1.8
Width trigonid M_2	1.4
Width talonid M_2	1.6

³ Named for the Huerfano River.

⁴ The species is named in honor of Mr. Hugo Rutherford of Gardner, Colorado, who generously aided the field parties of the American Museum and Yale.

ORDER PRIMATES (incertae sedis) or INSECTIVORA

FAMILY APATEMYIDAE

Apatemys, large species

Two specimens of a large *Apatemys*, AMNH 17454 and YPM 16444, have been collected from locality II. AMNH 17454 has both rami present, but with the exception of an incisor root, lacks teeth, whereas YPM 16444 has the root of the incisor and poorly preserved P_3-M_1 . The jaws are larger than those of *A. bellus* and smaller than the jaw of the type of *A. rodens* (see Table 7). The teeth of YPM 16444 are similar in size to those of *A. bellus*. Unfortunately the teeth are too poorly preserved to permit accurate comparison with Bridger specimens. AMNH 17454 shows that the number of alveoli per tooth is P_3 , one; P_4 , one; M_1-M_3 two each. The single rooted P_4 indicates that this character does occur in larger apatemyids (see Simpson, 1954, p. 3) and that the presence of two roots on P_4 may not be significant taxonomically. However, the Huerfano *Apatemys* are sufficiently different to warrant reservations in any reference to Bridger species.

Apatemys, small species

One specimen of a small *Apatemys*, YPM 16477, was collected at locality II. It consists of a fragment of the right jaw with incisor root, alveoli of P_{3-4} (one each) and M_3 ; M_1 and M_2 are present but poorly preserved. The jaw is comparable to that of *A. bellus* in size but the teeth are smaller than those of *A. bellulus*. The specimen is not of good enough quality to be used as a type; the application of a name awaits better material. Measurements are given in Table 7.

Huerfano *Apatemys* are unusual in that the teeth are relatively small. In both species the jaw is relatively massive, indicating that the Huerfano forms are relatively more specialized than *A. bellus* or *A. bellulus* of the Bridger. The Huerfano specimens may represent undescribed species, but their inclusion within *Apatemys* is reasonable. Although there is a great variability in the size of *Apatemys* jaws (see table 7) the variation in the size of the teeth is less. The jaw of a referred specimen of *A. bellulus*, AMNH 12048 is 4.8 mm deep and that of the type of *A. rodens* is almost twice as large, 9.3 mm. Yet the difference in the length of the respective P_4 's is 1.1 to 1.5 mm. There is a direct correlation between size of incisor and depth of jaw; a correlation also exists between the depth of jaw and molar tooth size, but the relative increase is less. *A. bellulus* and *A. rodens* cannot now be shown to belong to the same species, but I would not be surprised if additional data should indicate that they are conspecific.

FAMILY PHENACOLEMURIDAE

*Phenacolemur jepsoni simpsoni*⁵ new subspecies

Plate III, figure 2

TYPE. AMNH 2680, fragment of a right lower jaw with root of incisor, P_4-M_1 and alveoli of M_2 .

HYPODIGM. Type only.

DISTRIBUTION AND LOCALITY. Lost Cabin equivalent (lower faunal zone), Garcia Canyon local fauna, of Huerfano formation, Huerfano County, Colorado. The specimen was collected by Dr. Wortman in 1897 and the exact locality is not known. Most of Wortman's fossils from the lower faunal zone came from the Garcia Canyon area (locality VI).

DIAGNOSIS. P_4 significantly smaller than that of type of *P. j. jepsoni* from the stratigraphically much lower Almagre facies of the San Jose formation. The lack of expanded talonid heel readily separates this subspecies from the Almagre form. M_1 similar to *P. j. jepsoni*.

DISCUSSION. *P. jepsoni simpsoni* is more slender than *P. j. jepsoni*. The reduced size of the P_4 further exemplifies a trend for size reduction noted by Simpson (1955, p. 428). *Phenacolemur* has been recorded from Lost Cabin beds (Simpson, 1955), but the whereabouts of the Wyoming specimen are not known.

It is interesting that the Huerfano specimen, which has only recently come to light, was probably the first *Phenacolemur* ever to be collected.

⁵ Named for Dr. George Gaylord Simpson who recently monographed the Phenacolemuridae.

TABLE 7
Measurements of Apatemys (in Millimeters)
A. bellulus *Huerfano*
small sp.

	YPM* 13513 Type	AMNH 12060	AMNH 12048	YPM 16477
I width	—	—	1.3e	1.5
depth	—	—	2.5e	3.0
P ₃ length	—	—	—	—
width	—	—	—	—
P ₄ length	1.1e	0.9	1.1	—
width	—	0.7	0.8	—
M ₁ length	1.8	1.8	1.7	1.5
width	1.2	1.2	1.2	1.0
M ₂ length	1.9	—	1.9	1.7e
width	1.5	—	1.4	1.0e
Depth of Jaw at M ₂	—	—	4.8	5.0

	<i>A. bellus</i>					
	YPM* 13512 Type	USNM* 13276	AMNH 11425	AMNH* 12047	YPM 13520	YPM 11766
I width	1.5	1.6e	—	—	—	—
depth	3.0e	3.1	—	—	—	—
P ₃ length	—	—	—	—	—	—
width	—	—	—	—	—	—
P ₄ length	—	1.5	1.5	—	—	—
width	—	—	0.7	—	—	—
M ₁ length	—	—	—	2.0	2.3	—
width	—	—	—	1.4	1.4	—
M ₂ length	2.3	2.4	2.3	2.1	2.5	2.5
width	1.6	1.7	1.6	1.4	1.5	1.7
Depth of Jaw at M ₂	5.6	5.3	5.5	—	—	—

	<i>Huerfano</i> large sp.			<i>A. rodens</i>	
	YPM 16444	AMNH 17454 Right-Left		YPM* 12973 Type	USNM* 13277
I width	2.0	2.1	2.2	2.9	2.9
depth	4.1	3.9	3.8	5.4	6.0e
P ₃ length	2.2e	—	—	—	5.0e
width	1.1	—	—	—	2.1
P ₄ length	1.2	—	—	—	1.5
width	1.0	—	—	—	—
M ₁ length	2.2	—	—	—	—
width	1.4	—	—	—	—
M ₂ length	—	—	—	—	—
width	—	—	—	—	—
Depth of Jaw at M ₂	6.7	7.0	7.0	9.3	—

* = data from Gazin, 1958.
e = estimate.

TABLE 8

Measurements (in Millimeters) of *Phenacolemur jepseni* specimens

	P ₄		M ₁			Depth of Jaw at
	L	W	L	W-trigonid	W-talonid	
<i>P. j. jepseni</i> type						
AMNH no. 48005	2.6	1.7	2.3	1.6	1.7	7.1 mm
<i>P. j. simpsoni</i> type						
AMNH no. 2680	2.0	1.7	2.1	1.5	1.6	5.0

FAMILY MICROSYOPIDAE

McKenna (1960) has re-erected Matthew's family Microsyopidae to include the genera *Cynodontomys*, *Microsyops* and *Craseops*. Three species of microsyopids are found in the Huerfano formation: *Cynodontomys scottianus* and *C. knightensis* in the Garcia Canyon local fauna and *C. knightensis* and *M. lundeliusi* in the Gardner Butte local fauna. The distribution of these species is listed in Table 9.

TABLE 9

Numbers of individuals of microsyopid species at Huerfano formation localities

Species	Localities								
	I	II	III	V	IV	VI	VIII	VIIIa	X
<i>C. scottianus</i>	—	—	—	—	2	?1	—	—	—
<i>C. knightensis</i>	1	11	8	—	—	3	1	1	1
<i>M. lundeliusi</i>	2	32	1	1	—	—	—	—	—

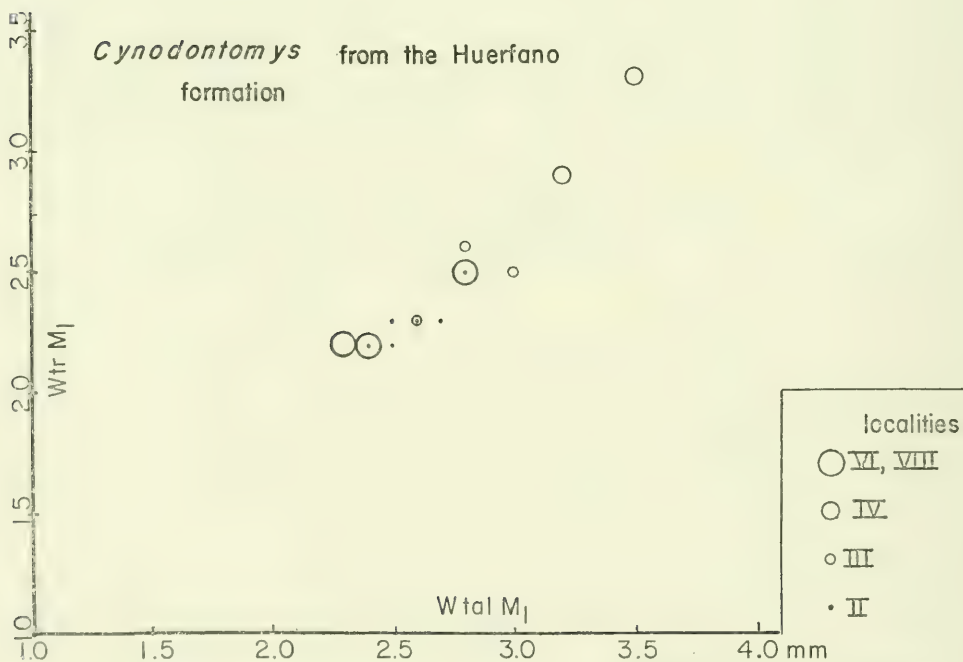


Figure 7. A scatter diagram comparison of widths of trigonid (Wtr) and talonid (Wtal) of M₁ of *Cynodontomys* from several localities in the Huerfano formation.

Cynodontomys scottianus (Cope, 1881)

Plate IV, figure 1

Two specimens, AMNH 17543 and YPM 16468, both from locality IV, are referred to this species, and AMNH 17544 from locality VI may also belong to it. *C. scottianus* is very similar to *Microsyops lundeliusi* in size (see Tables 10, 12) and may be ancestral to it. The P₄ of YPM 16468 is not as molariform as the same tooth in *C. knightensis*. The Huerfano *C. scottianus* lies near the upper limit of the range of tooth size for the *C. scottianus* from the Lost Cabin member of the Wind River formation. *C. knightensis* is at the lower end of this range. This size difference could be explained if the two were actually competitors. However, the known distribution shows that the two species probably inhabited different areas and, perhaps, environments.

TABLE 10

Measurements (in Millimeters) of lower teeth of *Cynodontomys scottianus* from the Huerfano formation

Specimen	Local- ity	P ₂		P ₃		P ₄		L	M ₁	W- tal- onid	L	M ₂	W- tal- onid
		L	W	L	W	L	W		W- tri- gonid			W- tri- gonid	
AMNH													
17543 left	IV	—	—	—	—	—	—	4.4	2.9	3.2	4.3	3.3	3.5
17543 right	IV	2.4	1.4	3.1	2.0	—	—	—	—	—	4.4	3.1	3.5
YPM													
16468	IV	—	—	—	—	4.2	3.3	4.3	3.3	3.5	—	—	—
<i>Cynodontomys ?scottianus</i>													
AMNH													
17544	VI	—	—	—	—	—	—	4.4	—	—	4.8	—	4.0

Cynodontomys knightensis Gazin, 1952

Plate IV, figure 2

MATERIAL. Locality I: AMNH 17471; Locality II: AMNH nos. 17473, 17482, 55161, 55162, 55166, 55167, 55168, 55225, 55286, field no. 1952-342; Locality III: AMNH nos. 17019, 17028, 17022, 17470, 55223, 55163, 55164, field no. 1952-538; Locality VI: AMNH nos. 55221, 55222; Locality VIII: AMNH nos. 55287, 55290, 55291; Locality VIIIA: AMNH 55288; Locality X: AMNH 17018.

This species is almost ubiquitous in both zones of the Huerfano formation except at locality IV, where it is seemingly replaced by *C. scottianus*. At least 25 specimens are known from both faunal zones. The absence of *C. knightensis* from locality IV and the presence of *C. scottianus* at that locality is probably of ecologic significance, even though the sample is small.

Gazin (1952, p. 20) noted that this species was the same size as *C. latidens* but morphologically like *C. scottianus*. The Huerfano *C. knightensis* is similar to *C. latidens* in size, but the mean of the Huerfano sample is slightly greater.

The sample of *C. knightensis* from locality II is composed of specimens whose mean size is slightly smaller than those from locality III. This is shown in the scatter-diagram, figure 7. This may be significant since *Microsyops lundeliusi* is so common at locality II, where similar sized individuals of the two species might have been competitors. However, the differences shown in figure 7 may be due to depositional agencies or to sampling error.

TABLE 11
Statistics (in Millimeters) of lower teeth of *Cynodontomys knightensis*

Variate	Locality	N	OR	M
Length	III	1		2.0
P ₃	X	1		3.1
Width	III	1		1.3
P ₃	X	1		1.9
Length	II	4	3.2-3.9	3.52
P ₄	III	4	3.4-3.8	3.60
	X	1		3.9
Width	II	4	2.0-2.7	2.43
P ₄	III	4	2.4-2.7	2.55
	X	1		2.6
Length	II	6	3.2-3.6	3.45
M ₁	III	3	3.7-3.8	3.77
	VI	1		3.8
	VIII	2	3.2-3.6	3.40
Width trigonid	II	6	2.2-2.5	2.28
M ₁	III	3	2.3-2.6	2.47
	VI	1		2.5
	VIII	2		2.2
Width talonid	II	6	2.4-2.8	2.50
M ₁	III	3	2.6-3.0	2.80
	VI	1		2.8
	VIII	2	2.3-2.4	2.35
Length	I	1		3.6
M ₂	II	5	3.5-3.8	3.62
	III	4	3.9-4.1	4.03
	VI	2	3.4-3.9	3.65
Width trigonid	I	1		2.4
M ₁	II	5	2.3-2.6	2.46
	III	4	2.7-2.9	2.87
	VI	2	2.3-2.6	2.45
Width talonid	I	1		2.9
M ₂	II	5	2.6-3.1	2.88
	III	4	3.0-3.1	3.05
Length	I	1		4.2
M ₃	II	3	3.8-4.2	4.10
	III	2	4.4-4.5	4.45
	VI	1		4.3
Width trigonid	I	1		2.2
M ₃	II	3	2.2-2.4	2.27
	III	3	2.3-2.6	2.50
Width talonid	I	1		2.8
M ₃	II	3	2.3-2.7	2.53
	III	3	2.5-2.8	2.67
	VI	1		2.7

The greater relative abundance of *C. knightensis* in the upper faunal zone is probably due to the fact that the upper zone is generally more fossiliferous than the lower zone.

C. knightensis is very similar to *M. elegans* from the lower Bridger beds, and probably is ancestral to the latter species. *M. elegans* has a more molariform P_4 than *C. knightensis* does and is slightly larger.

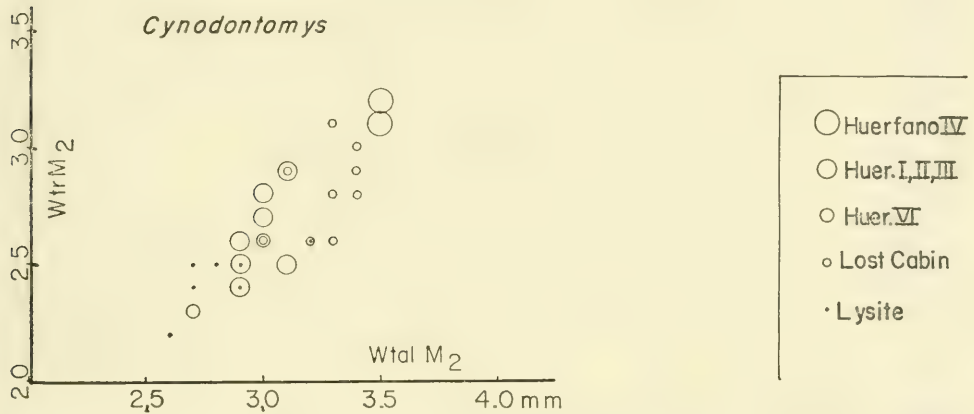


Figure 8. A scatter diagram comparison of widths of trigonid and talonid of M_2 of *Cynodontomys* from the Lysite, Lost Cabin and Huerfano beds.

Microsyops lundeliusi (White, 1952), New Combination
Plate IV, figure 6

MATERIAL. Locality I: AMNH 55214, YPM 16485; Locality II: AMNH nos. 17463, 17464, 17465, 17466, 17469, 17493, 55169, 55170, 55171, 55172, 55173, 55174, 55175, 55176, 55177, 55178, 55179, 55208, 55212, 55213, 55283, 55285; YPM nos. 14614, 16452, 16453, 16454, 16456, 16482, 16484; Locality III: AMNH 17468; Locality V: AMNH 17467.

Microsyops lundeliusi is represented by at least 36 specimens from localities I, II, III and V. All but four of these specimens are from locality II. The material includes a skull, several partial upper dentitions and many lower jaws. The skull, AMNH 55284, is being described elsewhere by McKenna.

White (1952, p. 191) placed this species in *Cynodontomys*; the type specimen, USNM 18371, lacks the fourth lower premolar. This tooth is preserved in fourteen of the Huerfano specimens and is more like that of *Microsyops elegans* than that of *Cynodontomys scottianus*. In *C. scottianus* the metaconid of P_4 is rounded and low. In *C. knightensis* the metaconid is similar to that of *M. elegans*, i.e. well developed, but the paraconid is still present. *M. lundeliusi* P_4 has a large metaconid, well separated from the protoconid, making the trigonid as wide as the talonid. The paraconid is lacking.

Summations (Table 12) of the widths of P_3 and P_4 suggest that sexual dimorphism was present in *M. lundeliusi*. The separation of the specimens into two groups of equal size is best explained by the presence of males and females. Presumably the males are larger (they are usually so in primates, and *Microsyops* is here considered a primate). The separation disappears in histograms of widths of the molars. Measurements have been listed for lower teeth only because upper teeth are rare.

The relative abundance of *M. lundeliusi* at locality II is interesting. Locality II is a rich locality; therefore it would be likely to have a plurality of the specimens of any species of upper Huerfano mammals. The relative lack of *Cynodontomys* (found in approximately equal numbers at localities II and III) and the small size (relative to other *C. knightensis*) of *Cynodontomys* at locality II indicate that the two species may have been

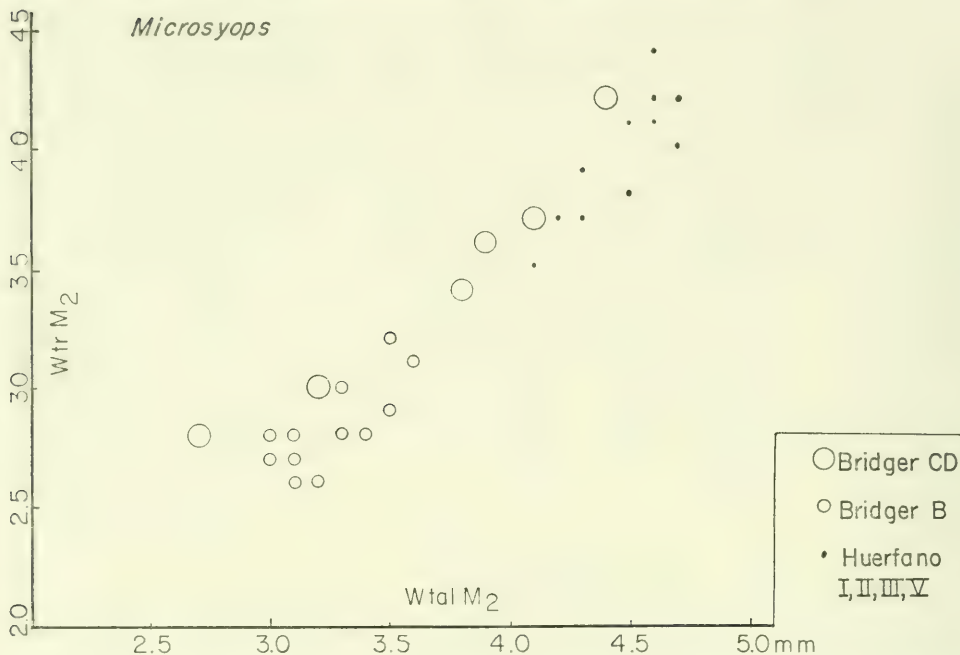


Figure 9. A scatter diagram comparison of widths of trigonid (Wtr) and talonid (Wtal) of M_2 of *Microsyops* from the Huerfano and Bridger formations.

competitors. The possibility exists, but is unsupportable at present, that *Microsyops lundeliusi* might have been semiaquatic or a swamp-dweller. The fossil-bearing exposures at locality II are all within 300 yards of a channel sandstone that is at the same level. The abundance of *M. lundeliusi* may be related to the proximity of a flowing stream.

The size of *M. lundeliusi* (see figure 12) is its most distinguishing character. That the earliest known *Microsyops* should be so large is startling. *M. lundeliusi* is larger than most of the *M. annectans* from the upper Bridger beds. *M. lundeliusi* is probably not the

TABLE 12

Measurements (in Millimeters) and statistics of lower teeth of *Microsyops lundeliusi*

Variate		N	OR	M	SD	V
P_3	Length	9	3.5-4.6	4.14	0.38	9.18
	Width ?male	5	3.3-3.6	3.44	0.13	3.78
	Width ?female	4	2.5-2.7	2.63	0.10	3.80
P_4	Length	13	5.0-6.5	5.67	0.51	8.99
	Width ?male	6	4.3-4.5	4.43	0.20	4.51
	Width ?female	7	3.6-3.9	3.77	0.27	7.16
M_1	Length	17	4.9-6.2	5.53	0.36	6.51
	Width trigonid	18	3.4-4.0	3.73	0.21	5.63
	Width talonid	16	3.8-4.5	4.19	0.25	5.96
M_2	Length	18	5.2-6.3	5.77	0.27	4.67
	Width trigonid	18	3.5-4.2	4.01	0.24	5.99
	Width talonid	19	4.1-4.7	4.53	0.17	3.75
M_3	Length	9	5.8-7.9	6.78	0.58	8.63
	Width trigonid	9	3.3-4.2	3.76	0.42	10.11
	Width talonid	9	3.8-4.5	4.19	0.31	7.40

ancestor of either *M. elegans* or *M. annectans*. *C. knightensis*, especially the Huerfano sample, would seem to be a proper morphological precursor of the Bridger forms. Perhaps *M. lundeliusi* arose from *C. scottianus*. Then the genus *Microsypops* (as here defined) would be polyphyletic in origin. Perhaps *M. lundeliusi* should be placed in a separate genus, but I cannot recognize any morphological reason for doing this. Placing *Cynodontomys* in synonymy with *Microsypops* would solve the semantic problem but not alter the interpretation.

M. lundeliusi may be the ancestor of *Craseops sylvestris*, but the latter might have arisen from *M. annectans* as well. The upper molars of *Craseops* are more specialized than those of *Microsypops* (Stock, 1934).

ORDER TILLODONTIA
FAMILY ESTHONYCHIDAE
SUBFAMILY ESTHONYCHINAE
Esthonyx acutidens (Cope, 1881)
Plate V, figure 8

Five individuals of *Esthonyx acutidens* have been collected from the lower faunal zone of the Huerfano formation. Four of the specimens are very poorly preserved but one, AMNH 17531 has the left P_3-M_3 and right P_4-M_3 . No. 17531 came from locality VI: the remaining specimens are not catalogued.

SUBFAMILY TROGOSINAE
Trogosus grangeri Gazin, 1953
Plate VIII, figure 2

PROBABLE SYNONYM: *T. hillsi* Gazin, 1953

MATERIAL. Locality I: AMNH 17008, type of *T. grangeri*; AMNH 17009; Locality II: AMNH 17495, YPM 16449; No locality data: USNM 17157 (Type of *T. hillsi*).

Trogosus grangeri is probably the commonest mammal in the upper faunal zone of the Huerfano formation; it is generally poorly preserved. Fragments of *Trogosus* incisors and cheek teeth are ubiquitous and are the most useful index fossils for the upper zone because of their large size and distinctive appearance.

Gazin's (1953) revision of the Tillodontia placed two species of *Trogosus* in the upper Huerfano faunal zone. *T. grangeri* and *T. hillsi* are based on skulls and lower jaws with poorly preserved teeth. Gazin (1953, p. 47) noted that the two specimens might be sexual dimorphs of one species. The two individuals might also show age differences. The basicranial differences noted by Gazin might be those of sexual dimorphism. The upper tooth rows of the two types (AMNH 17008, *T. grangeri*, and USNM 17157, *T. hillsi*) are of similar size: AMNH 17008 P^3-M^3 -85.0 mm, USNM 17157 P^3-M^3 -83.8 mm (Gazin 1953, p. 46, 48).

The Huerfano *Trogosus* show considerable variation in individual size. The length of the lower tooth series (P_3-M_3 at the alveoli) varies from 89.9 mm (AMNH 17008) to 122.2 mm (YPM 16449). The coefficient of variability is large for all variates for which it has been calculated; the variation is from 13.87-17.28. The largest sample is composed of four specimens. In reference to the variation, the difference in size between the same teeth in opposite jaws of the same individual is great. YPM 16449 has as much as a 12 per cent difference in one variate and over five per cent difference in three others. If the larger specimens of the Huerfano *Trogosus* represent a distinct species, it cannot be either *T. grangeri* or *T. hillsi* since these species are described from specimens at the lower end of the size range. The largest specimen collected from the Huerfano formation, YPM 16449, has the peculiar crest between the entoconid and hypoconid of M_3 mentioned by Gazin (1953, p. 44). This interesting morphological character found in all unworn M_3 's from the Huerfano formation, indicates a relationship between all the Huerfano *Trogosus* possessing it and adds to the evidence in favor of a single, variable population.

Trogosus grangeri has been collected at localities I, II, III and V.

TABLE 13

Measurements (in Millimeters) of lower teeth of *Trogosus grangeri*

Statistic	AMNH nos.	17009	17008	17495	YPM left	16449 right	V
P ₃	L	—	—	—	—	13.4	
	W	—	—	—	—	9.4	
P ₄	L	13.7	14.2	15.9	17.8	18.6	14.16
	W	12.9	14.2	14.3	17.7	16.4	13.87
M ₁	L	16.8	15.0	20.1	—	18.8	
	W-trigonid	13.9	15.9	—	—	19.5	
	W-talonid	13.0	—	—	18.1	16.7	
M ₂	L	20.0	18.2	—	22.0	22.3	
	W-trigonid	15.7	15.8	17.8	20.6	19.3	
	W-talonid	15.2	15.9	17.5	19.4	18.9	
M ₃	L	31.7	28.9	38.8	38.9	39.1	
	W-trigonid	15.8	15.6	—	21.1	18.5	
	W-talonid	14.1	14.9	15.2	20.1	17.6	
	W-hypoconulid	10.7	12.9	11.6	12.3	12.3	
P ₃ -M ₃	L at alveoli	—	89.9	—	—	122.2	17.14
M ₁ -M ₃	L at alveoli	70.0	65.0	88.4	84.4	85.7	14.85

Note: Note the variation between right and left sides of the same individual, YPM no. 16449.

ORDER TAENIODONTA
FAMILY STYLINODONTIDAE

Stylinodon sp.
Plate V, figure 1

MATERIAL. Locality II: AMNH 17451; Locality VI: AMNH 17525; Locality "South of Hausero's Ranch" (Collected by R. C. Hills): YPM 14616.

Three isolated *Stylinodon* teeth have been collected from the Huerfano formation. The genus being represented in both faunal zones. AMNH 17451 is from a smaller animal than the other specimens.

ORDER EDENTATA
SUBORDER Palaeanodonta
FAMILY METACHEIROMYIDAE

Metacheiromys sp.
Plate I, figures 4, 5

AMNH 18666, an astragalus, from 1 mile north of Gardner Butte is referable to *Metacheiromys*. The specimen is larger than YPM 13501 referred to *M. tatusia* by Simpson (1931, p. 305, 356) and may be about the size of *M. marshi*. A row of small pits is present under the head of the astragalus; the pits follow the rim of the condyle from one side to the other.

Comparative measurements are:

	Bridger <i>M. tatusia</i> YPM 13501	Huerfano <i>Metacheiromys</i> sp. AMNH 18666
Width trochlea	7.0 mm	10.0
Width head	4.7	6.4

ORDER RODENTIA
FAMILY PARAMYIDAE

A. E. Wood has recently (1962) monographed the paramyid rodents including those of the Huerfano formation. As Wood did not indicate which locality most of the specimens came from I do so below.

SUBFAMILY PARAMYINAE

Paramys copei copei Loomis, 1907

MATERIAL. Locality II: AMNH nos. 55118, 55124, 55127, 55128, 55134, 55195, 55198; Locality V: AMNH 17455; Locality VI (?): AMNH 2682; Locality VII: AMNH 17546.

It is not clear from Wood's statistical treatment (1962, p. 45, table 8) whether he has included all the specimens from various localities in his chart. If he has, and the sample size indicates so, then the statistical treatment is open to question. In that case samples from widely disparate localities (Wind River, Huerfano and San Jose formations among others) are handled as if they were part of one population.

Paramys excavatus gardneri Wood, 1962

MATERIAL. Locality I: AMNH nos. 17024, 55146; Locality II: 55120, 55129, 55130, 55133, 55137, 55150, 55193 (type); Locality III: Nos. 17456, 17458, 17459, 55141, 55143, 55196, 55199; Locality V: 17455, 55138, 55139; Locality VI: 17545.

Paramys huerfanensis Wood, 1962

MATERIAL. Locality II: AMNH nos. 55114 (type), 55115; Locality III: 17025.

Leptotomus costilloi Wood, 1962

MATERIAL. Locality VIII: AMNH nos. 55110, 55111 (type), 55113.

Leptotomus grandis Wood, 1962

MATERIAL. Locality II: AMNH nos. 17453, 55126, 55192; Locality III: 17452, 17457; Locality 5 of Hills: USNM 20137 (type, misprinted 10137 in Wood, 1962, p. 80); Locality C of Hills: USNM 20135.

Leptotomus huerfanensis Wood, 1962

MATERIAL. Locality II: AMNH nos. 55121, 55125 (type), 55149.

Leptotomus parvus Wood, 1959

MATERIAL. Locality III: AMNH 55951.

Thisbemys nini Wood, 1962

MATERIAL. Locality II: AMNH nos. 17026, 55132; Locality III: 17023, 17454, 55937, 55197.

SUBFAMILY REITHROPARAMYINAE

Reithroparamys huerfanensis Wood, 1962

MATERIAL. Locality X: AMNH 17031 (type).

SUBFAMILY MICROPARAMYINAE

Microparamys sp. B

MATERIAL. Locality II: AMNH 55200.

Wood used the accepted designation of early Bridgerian for the upper faunal zone of the Huerfano formation. However, the paramyid rodents offer some of the best evidence for considering the upper faunal zone late Wasatchian. The presence of *Paramys copei copei*, *Paramys excavatus* and *Thisbemys nini* all indicate Wasatchian age. Wood (1962, p. 80) was uncertain whether *Leptotomus grandis* was present in the Bridger formation. Only

Leptotomus parvus is definitely present in the Huerfano and Bridger formations (Wood, 1962, p. 85).

FAMILY SCIURAVIDAE

Several Sciuravid rodents are present in the Huerfano formation; most of them come from the upper faunal zone. The material is currently being studied by Mary R. Dawson.

TABLE 14
Distribution of the rodents in the Huerfano formation

Species	Locality	I	II	III	V	VII	IV	VI	VIII	X
<i>Paramys</i>										
<i>copei copei</i>		—	7	—	1	1	—	?1	—	—
<i>e. gardneri</i>		2	7	7	3	—	—	1	—	—
<i>huerfanensis</i>		—	2	1	—	—	—	—	—	—
<i>Thisbemys</i>										
<i>nini</i>		—	2	4	—	—	—	—	—	—
<i>Leptotomus</i>										
<i>costilloi</i>		—	—	—	—	—	—	—	3	—
<i>huerfanensis</i>		—	3	—	—	—	—	—	—	—
<i>grandis</i>		—	3	2	—	—	—	—	—	—
<i>parvus</i>		—	—	1	—	—	—	—	—	—
<i>Reithroparamys</i>										
<i>huerfanensis</i>		—	—	—	—	—	—	—	—	1
<i>Microparamys</i>										
sp. B		—	1	—	—	—	—	—	—	—

ORDER CARNIVORA

FAMILY MESONYCHIDAE

Mesonyx obtusidens (Cope, 1872)

Plate VI, figures 3, 4

Two specimens from the upper faunal zone of the Huerfano formation are referable to *Mesonyx obtusidens*. AMNH 17423, from locality III, is a jaw fragment with the canine and P₂-M₃ preserved; the cheek teeth are badly chipped. The length, C-M₃, of AMNH 17423 is 122 mm, only 5 mm smaller than that given by Matthew (1909, p. 489) for the species: 127 mm.

The second Huerfano specimen, AMNH 55272, from locality II, has P⁴-M² preserved. AMNH 55272 is from a younger individual than the specimen figured by Matthew (1909, p. 494, figure 94) and has a small metacone on P⁴. In Matthew's specimen, AMNH 12643, this cusp has been obliterated by wear. The parastyle and metastyle of M¹-M² of AMNH 55272 are less developed than that of AMNH 12643; therefore the upper molars are shorter in the Huerfano specimen.

Measurements (in Millimeters) of AMNH 55272 are:

Length M ¹	17.0
Width M ¹	15.9
Length M ²	13.8
Width M ²	15.4

FAMILY OXYAENIDAE

Oxyaena sp. cf. *O. lupina* Cope, 1874

Plate V, figures 6, 7

MATERIAL. Locality VI: AMNH nos. 2683, 17557, 55265, 55298.

Four fragmentary specimens of *Oxyaena* have been collected from locality VI. Osborn (1897, p. 255) described *O. huerfanensis*, basing the species on AMNH 2683. Denison (1938, p. 169) placed *O. huerfanensis* in synonymy with *O. lupina*, the type species of the

genus, and referred AMNH 17557 to *O. forcipata*. As Denison noted, the Huerfano *Oxyaena* are larger than typical San Jose individuals of *O. lupina*. The four Huerfano specimens seem to belong in a single population whose individuals were intermediate in size between *O. lupina* and *O. forcipata* of the San Jose formation.

The Huerfano sample of *Oxyaena* is younger than the San Jose sample. Although the specimens are either too poorly preserved or too fragmentary for adequate determination, I think the Huerfano sample is closer to *O. lupina*.

Denison's chart of the progressive development of M_2 is best when used with a larger sample. However, the statistics trigonid width/trigonid length of M_2 , talonid length/length of M_2 , and shear angle of M_2 , are nearly the same for *O. lupina* and *O. forcipata*.

Patriofelis sp. cf. *P. ulta* Leidy, 1870

Plate VI, figure 2

SYNONYMS: *P. coloradoensis* Matthew, 1909, *P. compressa* Denison, 1938

MATERIAL. Locality III: AMNH 17017 (Type of *P. compressa*); "Box Canyon," a locality of R. C. Hills mentioned also by Osborn (1897, p. 251) but not located on any map. YPM 16461; "Upper beds" AMNH 2691 (Type of *P. coloradoensis*).

Three specimens of *Patriofelis* sp. cf. *P. ulta* have been collected from the upper faunal zone of the Huerfano formation. All of these specimens are lower jaws; two have been made the types of species: *Patriofelis coloradoensis* Matthew, 1909 and *P. compressa* Denison, 1938. The type specimen of *P. coloradoensis*, AMNH 2691, has badly worn teeth but the form of the jaw is *Patriofelis*-like (Denison, 1938, p. 173). The type specimen of *P. compressa*, AMNH 17017, is 11 per cent larger than AMNH 2691 and has slightly narrower premolars (Denison, 1938, p. 173). The third specimen, YPM 16461, lacks teeth, but the dentary is almost whole and resembles AMNH 17017 closely.

The type of *P. ulta* is a toothless jaw fragment. Enough of the jaw is preserved to show the distinctive masseteric and temporal fossae that are characteristic of *Patriofelis*. *P. ulta* (plastotype YPM 10070) differs from the Huerfano sample mainly in the thickness of the jaw; *P. ulta* is slightly longer. If the Huerfano population is distinct it is likely to be of only subspecific rank and Matthew's 1909 name, *P. coloradoensis*, has priority.

?*Patriofelis*

AMNH 17427, fragments of the left maxilla, both zygomae and the sagittal crest from locality I, is questionably referred to *Patriofelis*. The infraorbital foramen is unusually close to the alveolus of the canine. Part of the apparent abnormal closeness in this specimen may be due to fracture of the canine alveolus. AMNH 17427 is the size of *P. ulta*.

FAMILY HYAENODONTIDAE

Sinopa sp. cf. *S. strenua* (Cope, 1875)

Plate VI, figures 1, 5

MATERIAL. Locality II: AMNH nos. 17421, 17422, 17431, 55211, 56501, 56506, 56510.

Eight specimens of *Sinopa* have been collected from locality II. The material is poorly preserved and fragmentary. The sample from locality II resembles *Tritemnodon* in the closeness of the paracone and metacone of M^{1-2} but differs from it in the possession of lingual cingula on the upper molars and in the slender proportions of the dentary.

Sinopa strenua is recorded from the Grey Bull and Lost Cabin faunas (Matthew, 1915a, p. 76); its possible presence in the upper faunal zone of the Huerfano formation is of little importance but does emphasize the lower Eocene affinities of that zone.

FAMILY MIACIDAE

SUBFAMILY VIVERRAVINAE

Didymictis sp. cf. *D. protenus* (Cope, 1874)

Plate VII, figures 1, 7

One specimen of *Didymictis*, YPM 16458 from locality VIII is referable, with doubt, to *D. protenus*. YPM 16458 has parts of both jaws with right M_{1-2} and left M_2 preserved. It is

smaller than specimens of *D. altidens* from the Lost Cabin (see Table 15) or Lysite substages (Kelley and Wood, 1954, p. 349) and is close to the size of *D. protenus curticens* from the Grey Bull beds (Simpson, 1937, p. 16).

Pertinent measurements are listed in Table 15.

Didymictis altidens Cope, 1880

Plate VII, figures 3, 5

AMNH 2677, and M_{1-2} and other tooth fragments, from locality VI is referable to *D. altidens*. Several other tooth fragments in the American Museum collection are probably referable to this species.

Measurements are listed in Table 15.

TABLE 15

Measurements (in Millimeters) of lower teeth of *Didymictis* from the Huerfano formation and the Lost Cabin beds of the Wind River formation.

		<i>D. ?protenus</i> YPM		<i>D. altidens</i> AMNH				<i>D. vanceleveae</i> AMNH	
		16458	4792	4793	4911	4794	2677	17424	56507
P_2	Length	—	type	—	—	—	—	10.9	—
	Width	—	—	—	—	—	—	4.7	—
P_3	Length	—	—	—	—	—	—	12.9	—
	Width	—	—	—	—	—	—	6.2	—
P_4	Length	—	—	—	—	—	—	14.4	—
	Width	—	—	—	—	—	—	7.3	—
M_1	Length	11.3	—	—	—	15.6	13.0	18.0e	16.9
	Width trigonid	6.8	—	10.1	—	9.3	8.6	10.7	9.5
	Width talonid	5.9	—	—	—	7.8	6.2	8.0	7.1
M_2	Length	7.4	8.4	8.9	9.9	—	8.6	10.8	—
	Width trigonid	4.7	5.6	5.6	6.5	—	5.3	6.8	—
	Width talonid	4.3	4.9	5.0	5.5	—	4.7	6.1	—
	Depth of jaw at M_2	17.4	20.5	—	—	—	—	31.0	—

Didymictis vanceleveae new species⁶

Plate VII, figures 2, 4, 6

TYPE. AMNH 17424, a fragment of the left jaw P_2 - M_2 ; M_1 damaged and lacking paraconid.

HYPODGM. Type and AMNH 17030, a skull with the muzzle missing; AMNH 17426, tooth fragments and left M^{1-2} , AMNH 56507 and M_1 .

HORIZON AND LOCALITY. Upper faunal zone, Huerfano formation, South-central Colorado. Specimens from localities I and X.

DIAGNOSIS. Larger than *D. altidens*, one lingual cusp on trigonid of M_2 , jaw deep and stout.

DISCUSSION. *Didymictis vanceleveae* is most easily distinguished from *D. altidens* by its larger size. The metacone of M^2 seems to be less reduced in referred specimens of *D. vanceleveae*, AMNH nos. 17030, 17426, than in a referred specimen of *D. altidens*, AMNH 14750, from the Wind River formation. M^2 resembles the same tooth in *D. protenus*.

The single lingual cusp on the trigonid of M_2 may be a variable character. Only the type specimen of *D. vanceleveae* has this tooth preserved. One specimen from the Wind River formation here referred to *D. altidens*, AMNH 4911, is somewhat larger than most *D. altidens* material (Table 15) and has the paraconid and metaconid quite close together, and the anterior cingulum of AMNH 4911 is broader than normal, more nearly like

⁶ Named in honor of Mrs. Eleanor van Cleve of Walsenburg, Colorado, who gave very generous support to the field work related to this study.

D. vanceleveae. The single lingual cusp of the trigonid of AMNH 17030 is directly lingual to the protoconid. Perhaps the paraconid fused with the metaconid, AMNH 4911 representing an intermediate structural stage. The location of the lingual trigonid cusp in *D. vanceleveae* is intermediate to the positions of the metaconid and paraconid in *D. altidens*.

Didymictis vanceleveae is, perhaps, the youngest known species of *Didymictis*. Unfortunately *Didymictis* is rare in the Huerfano formation, but the meager sample available indicates that the members of this genus increased in size as they evolved. The skull of *D. vanceleveae* must have been at least 190 mm long (estimated length, occipital condyle to premaxilla) compared with about 155 mm for *D. altidens* (estimate). Giles MacIntyre is revising the Miacidae and the description of this skull is left to him.

Viverravus gracilis Marsh, 1872

Plate V, figure 3

PROBABLE SYNONYM: *V. dawkinsianus* Cope, 1881

MATERIAL. Locality II: AMNH 17429; Locality III: AMNH 56505; Locality IV: YPM 16467; Locality VI: AMNH nos. 2678, 2679, 2681; Locality VII: AMNH 55210.

V. gracilis occurs in both upper and lower faunal zones of the Huerfano formation. Wortman (1901, p. 145) included the Lost Cabin species *V. dawkinsianus* in *V. gracilis*; Matthew (1915a) regarded the two species as doubtfully distinct and stated that the Lost Cabin species had smaller size. Tables 16 and 17 show that the Lost Cabin sample exceeded

TABLE 16
Measurements (in Millimeters) of lower teeth of type specimens of
Viverravus gracilis and *V. dawkinsianus*

Horizon	P ₄		M ₁			M ₂		
	L	W	L	W-trigonid	W-talonid	L	W-trigonid	W-talonid
Bridger B (YPM 11836) type: <i>V. gracilis</i>	5.5	2.0	5.3	3.3	2.8	4.0	—	2.0
Lost Cabin (AMNH 4788) type: <i>V. dawkinsianus</i>	5.1	1.9	5.8	3.3	2.7	4.2	2.4	2.0

the Bridger sample in the mean size and also generally the maximum size of the dental dimensions tabulated. Moreover, the type of *V. dawkinsianus* exceeds the type of *V. gracilis* (Table 16) in the length of its lower molars. Table 17 shows the complete overlap of the Wind River sample by the more varied Bridger sample for molar widths, despite the larger average size of the older forms. It also shows that the Huerfano sample coincides with the Lost Cabin and Bridger B samples for the same parameters.

However, the Huerfano sample has individuals with a shorter P₄ and may represent a distinct subspecies. No change is noted in the Huerfano specimens in time, most probably due to the few available specimens. *Viverravus* is variable enough so that erection of a new subspecies should await more material.

In the course of determining the species of *Viverravus* in the Huerfano formation, I inspected all the *Viverravus* material in both the American and Peabody Museums. The Huerfano specimens show that the hypocone of M¹ is well developed in *V. gracilis*, where it forms a broad circular shelf. The same cusp is missing in *V. acutus* (Matthew, 1915a, p. 28, fig. 22) and the posterior lingual cingulum is absent. A heavy anterior lingual cingulum occurs on M¹ of *V. gracilis*, AMNH 56505, but the protocone separates it from the posterior cingulum. The protoconal-parastylar distance is relatively greater in *V. gracilis* than in *V. sicarius*.

Viverravus sicarius Matthew, 1909

Plate V, figure 12

MATERIAL. Locality I: AMNH 56511; Locality II: AMNH nos. 17432, 56500, 56502, 56509, 56512, 56513, 56514, 56515.

Viverravus sicarius occurs at localities I and II. Both the upper and lower teeth are known, and oddly, the upper teeth are more common. The distinguishing feature of *V. sicarius*, aside from size, is the relative narrowness of the protoconal-parastylar distance of P⁴. The mean size of the Huerfano sample is smaller than the dimensions of the type specimen, AMNH 11521 from Bridger B. One Huerfano specimen, AMNH 56515, is larger than the type. The hypocone of M¹ is not as well developed in the Huerfano individuals as it is in the type. Additional material from both the Bridger and Huerfano formations may indicate a subspecific difference in the two populations; present data are not significant because of the small size of the Bridger sample.

TABLE 17

Measurements (in Millimeters) and statistics of lower teeth of *Viverravus gracilis*

Horizon or locality	P ₄ Length			P ₄ Width		
	N	OR	M	N	OR	M
Lost Cabin	4	5.1-5.6	5.35	4	1.9-2.3	2.10
Huerfano VI	2	4.5-4.7	4.60	2	1.9	1.9
Huerfano IV	—	—	—	—	—	—
Huerfano II	1	—	4.2	1	—	1.7
Huerfano VII	—	—	—	—	—	—
Bridger B	4	5.0-5.6	5.30	4	1.8-2.1	1.93
Horizon or locality	M ₁ Length			M ₁ Width trigonid		
	N	OR	M	N	OR	M
Lost Cabin	5	5.5-6.2	5.80	4	3.3-3.3	3.25
Huerfano VI	2	4.6-5.2	4.90	2	2.9-3.0	2.95
Huerfano IV	1	—	5.7	1	—	3.2
Huerfano II	1	—	5.2	1	—	2.7
Huerfano VII	1	—	5.7	1	—	3.3
Bridger B	9	4.9-6.1	5.35	—	—	—
Horizon or locality	M ₁ Width talonid			M ₂ Length		
	N	OR	M	N	OR	M
Lost Cabin	4	2.4-2.8	2.60	4	4.1-4.2	4.18
Huerfano VI	2	—	2.3	1	—	4.0
Huerfano IV	1	—	2.5	1	—	4.0
Huerfano II	1	—	1.9	—	—	—
Huerfano VII	1	—	2.5	1	—	4.3
Bridger B	9	2.0-2.6	2.31	3	3.8-4.4	4.07
Horizon or locality	M ₂ Width trigonid			M ₂ Width talonid		
	N	OR	M	N	OR	M
Lost Cabin	2	2.4-2.5	2.45	3	1.9-2.0	1.97
Huerfano VI	1	—	2.2	—	—	—
Huerfano IV	1	—	2.3	1	—	2.1
Huerfano II	—	—	—	—	—	—
Huerfano VII	1	—	2.5	1	—	2.0
Bridger B	2	1.9-2.3	2.10	3	1.5-2.0	1.83

TABLE 18

Measurements (in Millimeters) of lower teeth of *Viverravus sicarius* from the Huerfano and Bridger formations

Locality	No.	P ₄		L	M ₁		L	M ₂	
		L	W		W-trigonid	W-talonid		W-trigonid	W-talonid
Huerfano	AMNH								
II	17432	7.1	3.4	7.8	4.0	3.4	—	—	—
V	55209	—	2.5	6.8	3.6	3.1	4.9	2.6	2.3
II	56509	6.1	2.5	7.4	3.7	3.1	—	—	—
Bridger B	AMNH								
	11521*	7.7	3.3	8.2	4.8	3.4	5.3	—	—
	YPM								
	13116	—	—	7.7	4.5	3.3	—	—	—
	12882	—	—	8.7	4.7	3.7	—	—	—

* type *V. sicarius*.

TABLE 19

Measurements (in Millimeters) of upper teeth of *Viverravus sicarius* from the Huerfano and Bridger formations

Locality	AMNH nos.	P ₄			M ¹		
		L-buccal	L-protocone metastyle	W	L-buccal	L-lingual	W
Huerfano II	56512	8.0	9.4	5.2	—	—	—
II	56500	8.2	10.3	6.4	5.1	3.6	—
II	56502	—	—	—	5.2	3.1	8.1
II	56511	8.6	10.0	5.6	5.1	3.4	8.4e
I	56511	9.3	10.7	5.6	—	—	6.5e
Bridger B	15211*	9.4	10.2	6.0	6.1	3.6	8.7

* type *V. sicarius*.

SUBFAMILY MIACINAE

Miacis sp. cf. *M. parvivorus* (Cope, 1872)

Plate V, figure 10

AMNH 17435, a left M² with roots of M¹ and two alveoli of M³, from locality II is close to if not conspecific to *Miacis parvivorus*. The specimen differs from *M. latidens* of the Lost Cabin in having the posterior margin of the tooth deeply concave. Specimens of *M. parvivorus*, for example AMNH 11500 (Matthew, 1909, p. 364, fig. 15), have a similar outline. *M. latidens* and *M. parvivorus* are of similar size.

Pertinent measurements of AMNH 17435 are: Buccal length M², 3.0 mm; lingual length, 2.3 mm; width, parastyle to protocone M², 6.5 mm.

Uintacyon sp. cf. *U. asodes* Gazin, 1952

Plate V, figure 4

A fragment of the right jaw of *Uintacyon* from locality II, AMNH 17434, with P₄-M₁ preserved, seems close to *U. asodes* as far as may be determined from comparison of the photograph (Gazin, 1952, plate 6) of the damaged type specimen, USNM 19351. Measurements of the two specimens, listed below, show their similarity in size, the main criteria for association.

	Length P ₄	Width P ₄	Length M ₁	Width trigonid	Width talonid M ₁
USNM 19351 (from Gazin)	6.1 mm	3.3	7.5	5.5	—
AMNH 17434	6.4	2.9	7.3	4.6	3.1

Oödetes herpestoides Wortman, 1901

Plate V, figure 11

Two specimens referable to *Oödetes herpestoides* Wortman have been collected in the upper faunal zone: one specimen, AMNH 55289, is from locality II; the other, AMNH 56504, a maxilla fragment with parts of P³-M² is from locality III. Both show great resemblance to *O. proximus* Matthew as well as to *O. herpestoides* Wortman and it is likely that the two species are synonymous. *O. herpestoides* has priority. *O. pugnax* (Wortman and Matthew) may also be a synonym, and it has priority over both of the above names. However, the type of *O. pugnax* is a lower jaw, and direct comparison with the Huerfano specimens is not possible. Giles MacIntyre is currently revising the Miacidae and will resolve the problem of synonymy in *Oödetes*.

The Huerfano specimens are somewhat larger than the type specimen of *Oödetes herpestoides* but not enough to warrant specific separation. Pertinent measurements are listed in Table 20.

TABLE 20

Measurements (in Millimeters) of upper teeth of *Oödetes* from the Huerfano and Bridger formations

No. AMNH	P ³		P ⁴		Buccal	M ₂	
	L	W	L	W		Lingual L	Anterior W
55289	—	—	—	—	3.4	2.5	5.7
56504	4.5	2.5	5.4	4.3	—	—	5.3
11495	—	—	4.6	3.7	3.1	2.3	5.3
type of <i>O. proximus</i> from Bridger B							
YPM							
11861	—	—	4.2	4.0	3.1	2.0	5.2
type of <i>O. herpestoides</i> from Bridger B							

? *Oödetes*

Plate V, figure 9

AMNH 2681 from the lower faunal zone (locality VI?) is a jaw fragment with P₄-M₂ preserved. Alveoli for Canine, P₁ (one), P₃ (two) and the roots of P₂ are present. Two mental foramina lie below the alveolus of P₁ and the anterior alveolus of P₃. The tips of the protoconids of P₄ and M₁ and the talonid rim of M₂ are lost. The M₂ is peculiar in that it is smaller than the M₁ but is not as small as is usual in Miacidae. The metaconid and paraconid of M₂ are low and of equal size; the protoconid is tall. The paraconid and metaconid are not as close together as in *Oödetes*, the only miacid that closely resembles this specimen. This specimen may be an insectivore, but it is unlike any known to me.

The miacid-like M_1 argues against any insectivore relationship. The smaller M_2 is unlike the hyaenodonts.

Measurements (in Millimeters) of AMNH 2681

	P_4	M_1	M_2
Length	3.8	5.0	3.8
Maximum Width	2.1	3.6	2.3

Vulpavus asius Gazin, 1952

Plate V, figure 2

Two specimens, AMNH nos. 56503 and 56508, referable to *Vulpavus asius* have been collected at locality II. Both are jaw fragments with M_2 preserved, in which the paraconid lies close to the metaconid, as noted by Gazin (1952, p. 58, plate 5), for M_1 and also illustrated in his photograph of the type M_2 . The lengths of the two teeth are: AMNH 56503, 5.0 mm; 56508, 5.6 mm.

The proximity of the paraconid and the metaconid is not usual in *Vulpavus*. Most American Museum specimens of early Eocene *Vulpavus* show the paraconid of M_2 placed more centrally. One specimen, AMNH 16954 from Dorsey Creek in the Bighorn Basin, has the paraconid shifted to the position in *V. asius*, showing that the condition existed in some pre-Lostcabinian *Vulpavus*.

ORDER CONDYLARTHRA

FAMILY PHENACODONTIDAE

Phenacodus vortmani (Cope, 1882)

Plate X, figure 6

MATERIAL. Locality VI: AMNH nos. 17547, 55229, 55278, 55279, 55280, 55276. Locality IX: AMNH nos. 55230, 56532. AMNH 17548 from locality VI is questionably referred to *P. vortmani*.

Nine specimens, all fragments of lower jaws, from localities VI and IX are referred to *Phenacodus*. The specimens possessing a P_4 agree well with the type of *P. vortmani* AMNH 4824, also a P_4 . The measurements of the type are:

Length: 8.1 mm Width: 5.5 mm

In most measurements the coefficient of variability is low, but for the measurements of M_3 it is unusually high. This is due to the inclusion of one specimen, AMNH 17548.

The pertinent statistics are:

A: AMNH 17548 included:	N	OR	M	SD	V
Length M_3	5	7.8-10.1	8.66	0.94	10.85
Width trigonid	5	5.3-7.5	6.12	0.85	13.89
Width talonid	5	4.6-6.8	5.36	0.93	17.35

B: AMNH No. 17548 excluded:

Length	4	7.8-8.8	8.30	0.58	6.99
Width trigonid	4	5.3-6.2	5.78	0.40	6.92
Width talonid	4	4.6-5.8	5.00	0.54	10.80

Omitting AMNH 17548, the coefficient of variability for the talonid width of M_3 is still high in set B but is of more reasonable value. The sample is admittedly small, and the high coefficient of variability may be due to this, but the data suggest that the sample of M_3 's is heterogeneous. AMNH 17548 may be referable to either *P. copei* or *P. intermedius* (Granger, 1915, p. 333) on size characters. Since the specimen has only the third molar, it seems best to consider it *P.?* *vortmani*. The lack of other large *Phenacodus* specimens may be significant.

Comparison of the statistics of the Huerfano and Wind River samples of *P. vortmani*

(see Table 21) shows that in most parameters the Huerfano animals averaged smaller. The Wind River sample used is small (three specimens: AMNH nos. 4824, the type, 17487, and 14801), and the Huerfano sample is not much larger. The evidence is insufficient to establish the Huerfano population a subspecies of *P. wortmani* until the genus *Phenacodus* is reviewed and possible synonymy determined. The Wind River specimens used in the above comparison are the smallest *Phenacodus* from the Lost Cabin fauna at the American Museum of Natural History. *P. brachypternus*, the only smaller species of *Phenacodus*, is restricted to the lower part of the early Eocene (Grey Bull and Almagre faunas, Granger, 1915, p. 345).

TABLE 21

Measurements (in Millimeters) of lower teeth of *Phenacodus wortmani* from the Lost Cabin levels of the Huerfano and Wind River formations

Variate		Huerfano					Wind River		
		N	OR	M	SD	V	N	OR	M
P ₃	Length	1	—	6.9	—	—	2	7.3–7.7	7.50
	Width	1	—	4.1	—	—	2	—	4.5
P ₄	Length	3	7.7–8.0	8.00	—	—	3	7.9–8.4	8.13
	Width	3	5.1–5.6	5.37	—	—	3	5.4–5.6	5.50
M ₁	Length	3	7.5–7.6	7.53	—	—	3	7.5–7.7	7.60
	Width trigonid	4	6.2–6.6	6.35	0.19	3.00	2	—	6.9
	Width talonid	2	—	6.4	—	—	1	—	6.9
M ₂	Length	5	7.3–7.7	7.50	0.16	2.13	2	7.8–8.0	7.90
	Width trigonid	5	6.4–6.8	6.62	0.18	2.72	2	7.1–7.3	7.20
	Width talonid	5	6.1–6.6	6.32	0.19	3.01	2	7.0–7.1	7.05
M ₃	Length	4	7.8–8.8	8.30	0.58	6.99	2	7.8–9.2	8.50
	Width trigonid	4	5.3–6.2	5.78	0.40	6.92	2	5.8–6.5	6.15
	Width talonid	4	4.6–5.8	5.00	0.54	10.80	2	5.1–5.6	5.35

FAMILY HYOPSODONTIDAE

GENUS *HYOPSODUS* Leidy, 1870

Hyopsodus, although, or because, it is the commonest lower and middle Eocene mammal, is a systematist's nightmare. The latest revision of the genus is found in Matthew (1909 and 1915b). Since *Hyopsodus* is common, statistical treatment of the genus should be more valid than for other less common beasts. Olson and Miller (1958) did not segregate their Bridger specimens by individual localities, instead they segregated samples from the two faunal levels (Matthew, 1909). Gazin (oral communication) believes that Matthew's determination of the stratigraphy of the Bridger formation is open to reevaluation, and for this reason Olson's and Miller's conclusions are open to reevaluation. Kelley and Wood (1954) examined the *Hyopsodus* from the Lysite member of the Wind River formation and were able to show that three populations probably existed in that fauna: *H. minor*, *H. mentalis* and *H. powellianus*. Kelley and Wood measured the maximum width of M₁ and M₂. In these teeth the maximum width may be either on the trigonid or the talonid; a summation of maximum widths therefore is the summation of part of the sample of two variables and is less useful. The maximum width of M₃ is always across the trigonid.

The samples from the Lost Cabin member of the Wind River formation indicate that three populations exist: these are: *H. wortmani*, the small animals, and *H. walcottianus* and perhaps *H. mentalis*, the larger animals (Matthew, 1915b).

Two populations seem to be present in each level of the Huerfano formation. In the lower level the equation of these samples with samples from the Lost Cabin member of the Wind River formation is practical. The upper zone samples are harder to allocate.

The Garcia Canyon local fauna sample from the Huerfano formation is assigned to *H. wortmani* and *H. walcottianus*.

Frequency distributions of measurements of the trigonids of molars of *Hyopsodus* are from the following levels: Lysite-Bighorn and Wind River basins; Lost Cabin-Wind River and Huerfano basins, Gardner Butte-Huerfano basin; Black's Fork Bridger Basin. These distributions indicate that the populations of each level in each basin are distinct. The closest similarity between population samples is between the Lost Cabin levels of the Wind River and Huerfano basins. I have not examined the samples from the Largo and Almagre levels of the San Jose formation, or from the Grey Bull level of the Willwood formation. Although the number of named species of *Hyopsodus* is too great, each population in each fauna probably deserves subspecific rank. *H. mentalis* was based on a specimen from the San Jose formation. Referring samples from Wyoming to this species is probably valid, but, until the variation of the San Jose sample is known, it is risky.

Determining the species of *Hyopsodus* on morphological differences is, at the present time, impractical; the animals are variable. Olson and Miller's treatment is invalidated due to the lack of locality association (see above). My own analysis indicates only one variable (in terms of topography of the tooth) population in the lower Bridger. The sample from Grizzly Buttes (Bridger B) has low coefficients of variability for the parameters used.

Hyopsodus wortmani Osborn, 1902

Plate X, figure 5

MATERIAL. Locality I: AMNH nos. 17029, 55253, YPM 16412; Locality II: AMNH nos. 17474, 17475, 55256, 56521, 55237, 55233, 55240, 55236, 55258, 55232, 55239, 55234, 55235, 56518, 56519; Locality III: AMNH nos. 55245, 55244, 56520, 17476; Locality V: AMNH nos. 55241, 55243, 55242; Locality VI: AMNH nos. 16907, 17452, 55255; Locality VIII: AMNH 55257; Locality VIIa: AMNH 55260.

Hyopsodus wortmani is present in both faunal levels of the Huerfano formation. The sample from the upper faunal zone is composed of slightly smaller individuals than those of the lower zone sample (Tables 25, 26). This may be related to the presence of *H. paulus* in the upper zone. *H. paulus*, though larger than *H. wortmani*, is much smaller than *H. walcottianus* from the lower zone. The small individuals of *H. wortmani* in the upper zone may reflect the competition with a small related species of similar habit.

The sample of small *Hyopsodus* from the Lost Cabin level of the Wind River formation is bimodal (see Tables 22, 23, 24, frequency distributions of trigonid widths). Where measurements are restricted to specimens from one locality in other formations the separation of groups is sharp. Grouping the specimens from the Lost Cabin level of the Wind River formation according to locality might resolve this, but it cannot be done now. The smallest group in the Lost Cabin (Wind River) sample is *H. wortmani*. The sample with which it intergrades in size may be *H. mentalis*. *H. walcottianus* is the large species present. The statistics on the two smaller samples have been calculated together because I have no way of separating them at this time. This explains the high coefficients of variability.

Hyopsodus paulus Leidy, 1870

Plate X, figure 9

Two specimens, YPM 16435 from locality III and YPM 16486 from locality II are referable to *H. paulus*. Both specimens are isolated lower molars and add nothing to our knowledge of the species except its distribution.

Hyopsodus walcottianus Matthew, 1915

Plate X, figure 7

MATERIAL. Locality IV: AMNH nos. 17534, 17537, 17540, 17541, 55247, 55249, 55250, 55251, 55254, YPM nos. 16446, 16469, 16470; Locality VI: AMNH nos. 17535, 17536, 17538, 16906, 16905, 55259, YPM 16447.

H. walcottianus occurs at localities IV and VI, abundantly at the former. The range of size of the Huerfano specimens overlaps the size range of the *H. powellianus* popula-

tion from the Lysite fauna of the Willwood formation. The *H. walcottianus* sample from the Wind River Lost Cabin consists of three specimens whose size range is almost the same as that of the Huerfano sample (see Table 26). The Huerfano, Garcia Canyon, and the Wind River, Lost Cabin, samples are obviously related and both show relationship to the Willwood Lysite sample. Possibly *H. walcottianus* is a temporal subspecies of *H. powellianus*, but actual designation of it as such awaits a revision of the genus *Hyopsodus*.

The relative abundance of *H. walcottianus* at locality IV and the absence of *H. wortmani* from that locality is further evidence for the unique nature of Locality IV and the Farisita formation in general.

TABLE 22

Frequency distribution of widths of trigonids of M_1 of *Hyopsodus* from Lysite, Lost Cabin, Gardner Butte and Blacks Fork faunal levels

Width	Willwood Lysite	Wind River Lysite	Wind River Lost Cabin	Huerfano Lost Cabin	Gardner Butte	Bridger Blacks Fork*
2.0 mm	1					
2.1						
2.2		1			1	
2.3			2	1	2	
2.4			2		3	1
2.5			2		5	
2.6			3	1	2	
2.7	3		4			
2.8	2	4	4			6
2.9	3	3	1			13
3.0	2	2	8			26
3.1		1	2			18
3.2	1		2			3
3.3		1	2			3
3.4	1	3	1			
3.5	1	4	1			
3.6		8		1		
3.7		3				
3.8		3	1	2		
3.9	3	3		1		
4.0	4		1	2		
4.1	2	1		1		
4.2	3	1		1		
4.3	2			1		
4.4	2			5		
4.5			2	3		

* All specimens from Grizzly Buttes.

TABLE 23
Frequency distribution of widths of trigonids of M_2 of *Hyopsodus*

	Willwood Lysite	Wind River Lysite	Lost Cabin	Huerfano Lost Cabin	Gardner Butte	Bridger Blacks Fork*
2.4 mm	1				1	
2.5						
2.6					3	
2.7		1	2		4	
2.8			1	1	9	
2.9	1		2		2	
3.0	1		3		3	1
3.1		1	7			
3.2	3	3	1	1		1
3.3	3	3	4	1		6
3.4		3	3	1		15
3.5	4		3	1		21
3.6		1	3			15
3.7		1	2		1	11
3.8			1			1
3.9	1	2				
4.0		6	1			1
4.1	1	7				
4.2		6		1		
4.3	2	2				
4.4	1	5		1		
4.5	1	1		1		
4.6	2	1		1		
4.7	5	1		2		
4.8	1		1	3		
4.9	3			2		
5.0	1			4		
5.1	2			1		
5.2			1	2		
5.3				1		
5.4						
5.5			1			

* All specimens from Grizzly Buttes.

TABLE 24

Frequency distributions of widths of trigonids of M_3 of *Hyopsodus*

	Willwood Lysite	Wind River Lysite	Wind River Lost Cabin	Huerfano Lost Cabin	Gardner Butte	Bridger Blacks Fork*
2.2 mm	1					
2.3					2	
2.4					2	
2.5			1		4	
2.6			2		4	
2.7	1		1		3	1
2.8	2		3		1	
2.9		3	3	2	2	
3.0	1	7	2	1		4
3.1	4		2			15
3.2	2	2	4			19
3.3			4			15
3.4						11
3.5	1		1			4
3.6		7	2			
3.7		5				1
3.8		4	1			
3.9	2	2				
4.0	3	3		1		
4.1	1	2				
4.2	1	2	1	2		
4.3				2		
4.4	2			1		
4.5				2		
4.6				2		
4.7			1			
4.8						
4.9						
5.0				1		
5.1			1			

* All specimens from Grizzly Buttes.

TABLE 25

Measurements (in Millimeters) of trigonid widths of molars of small species of *Hyopsodus*, excluding *H. minor*, from several faunas

Fauna	Formation	N	OR	M ₁	S	V
				M		
Lysite	Willwood	12	2.7-3.5	2.97	0.23	7.74
Lysite	Wind River	10	2.8-3.1	2.90	0.18	6.21
Lost Cabin	Wind River	34	2.3-3.5	2.86	0.30	10.49
Lost Cabin	Huerfano	2	2.3-2.6	2.45	—	—
Gardner Butte	Huerfano	13	2.2-2.6	2.44	0.08	3.27
Blacks Fork	Bridger					
	AMNH	51	2.8-3.3	3.01	0.15	4.95
	YPM	18	2.8-3.3	3.01	0.17	5.51
M ₂						
Lysite	Willwood	12	3.0-3.9	3.37	0.17	5.04
Lysite	Wind River	12	3.1-3.7	3.34	0.35	10.48
Lost Cabin	Wind River	33	2.7-4.0	3.27	0.28	8.56
Lost Cabin	Huerfano	5	2.7-3.5	3.22	0.31	9.63
Gardner Butte	Huerfano	24	2.4-3.1	2.80	0.17	6.07
Blacks Fork	Bridger					
	AMNH	51	3.2-4.0	3.51	0.21	5.82
	YPM	18	3.3-3.7	3.57	0.11	3.03
M ₃						
Lysite	Willwood	11	2.7-3.5	3.05	0.28	9.18
Lysite	Wind River	12	2.9-3.2	3.01	0.19	6.32
Lost Cabin	Wind River	26	2.5-3.8	3.08	0.37	12.01
Lost Cabin	Huerfano	3	2.9-3.0	2.93	—	—
Gardner Butte	Huerfano	19	2.3-2.9	2.59	0.18	6.95
Blacks Fork	Bridger					
	AMNH	51	3.0-3.7	3.22	0.20	6.21
	YPM	18	2.8-3.3	3.01	0.17	5.51

TABLE 26

Measurements (in Millimeters) and statistics of trigonid widths of molars of large species of *Hyopsodus*

Fauna	Formation	N	OR	M	S	V
M ₁						
Lysite	Willwood	16	3.9-4.4	4.12	0.14	3.40
Lysite	Wind River	27	3.3-4.2	3.66	0.49	13.39
Lost Cabin	Wind River	3	4.0-4.5	4.33	—	—
Lost Cabin	Huerfano	17	3.6-4.5	4.19	0.26	6.21
M ₂						
Lysite	Willwood	19	4.1-5.1	4.68	0.35	7.48
Lysite	Wind River	31	3.9-4.7	4.20	0.49	11.69
Lost Cabin	Wind River	3	4.8-5.3	5.17	—	—
Lost Cabin	Huerfano	19	4.2-5.3	4.85	0.23	4.74
M ₃						
Lysite	Willwood	9	3.9-4.4	4.10	0.19	4.63
Lysite	Wind River	25	3.6-4.2	3.81	0.52	13.64
Lost Cabin	Wind River	3	4.2-5.1	4.63	—	—
Lost Cabin	Huerfano	11	4.0-5.0	4.42	0.23	5.20

ORDER DINOCERATA

FAMILY UINTATHERIIDAE

Bathyopsis sp. cf. *B. fissidens* (Cope, 1881)

Plate I, figure 6

Bathyopsis sp. cf. *B. fissidens* occurs at locality III and probably at locality I. AMNH 17438, a left P₂ (not ?P₃ or P₄, Wheeler, 1961) from locality III agrees well with the type AMNH 4820. AMNH 17444, skeletal fragments of a uintathere, from locality I may pertain to *B. fissidens*; the astragalus is smaller and less specialized than that of *Uintatherium*. No uintathere remains have been found in the lower faunal zone.

Measurements (in Millimeters) of AMNH 17438 are:

Length	Width trigonid	Width talonid
14.8	8.9	8.4

ORDER PANTODONTA

FAMILY CORYPHODONTIDAE

Coryphodon sp.

Plate I, figure 8

Numerous fragmentary specimens of *Coryphodon* occur in the lower faunal zone, and one specimen, AMNH 56543, a left P₃, was collected at locality II. The specimens now prepared are too fragmentary for specific identification. Better material and a revision of the genus *Coryphodon* will be necessary before accurate determinations can be made.

Specimens of this genus occur at localities VI, VIII, VIIIA, IX and an isolated specimen, YPM field no. 59-12, was collected in exposures about 1/4 mile west of locality IV. AMNH nos. 2690 and 17556 are the only catalogued specimens from the lower faunal zone.

The *Coryphodon* specimen from the upper faunal zone may be the youngest record of the genus in North America.

ORDER PERISSODACTYLA

FAMILY EQUIDAE

Hyracotherium craspedotum (Cope, 1880)

Plate IV, figure 3

MATERIAL. (K) = Kitts' sample: Locality VI: AMNH nos. 17509(K), 17510(K), 17513(K), 17521, 55100(K); Locality IX: AMNH nos. 56530, 56532.

The sample of horses used in this study differs from Kitts' (1956) sample for several reasons: Kitts included material from Locality VIII (Costillo Pocket) in his study, and did not include, in most cases, material from the upper faunal zone. Also, I have the advantage of having material collected since Kitts' study was completed. Kitts omitted several specimens with numbers of the 2,000 series (collected in 1897) and the 17,000 series (collected in 1916, 1918) from his studies. Differences in data between Kitts' sample and mine arise from using some different individuals.

TABLE 27

Measurements (in Millimeters) of lower teeth of *Hyracotherium craspedotum* and *H. vasacciense* from the Huerfano and Farisita formations:

Variate	Locality	N	OR	M	SD	V	Species
M ₁ Length	II, III, V.	4	7.2-7.6	7.40	—	—	<i>H. vasacciense</i>
	VI	9	6.4-8.4	7.32	0.68	9.29	"
	IV	2	7.8-9.0	8.40	—	—	"
	VI, IX	4	8.8-9.6	9.20	—	—	<i>H. craspedotum</i>
	Width trigonid	II, III, V.	4	5.2-5.3	5.28	—	—
		VI	9	4.5-5.9	5.04	0.50	5.85
		IV	2	5.6-6.1	5.85	—	—
		VI, IX	4	6.2-6.5	6.40	—	—
	Width talonid	II, III, V.	4	5.2-5.5	5.33	—	—
		VI	10	4.6-6.2	5.27	0.47	8.92
		IV	2	5.8-6.5	6.15	—	—
		VI, IX	4	6.5-6.7	6.58	—	—
M ₂ Length	II, III, V.	7	7.1-8.1	7.61	—	—	
	VI	10	7.1-8.5	7.61	0.54	7.06	
	IV	3	8.1-9.2	8.65	—	—	
	VI, IX	6	9.7-10.4	10.01	—	—	
	Width trigonid	II, III, V.	7	4.9-5.8	5.49	—	—
		VI	11	5.0-6.3	5.57	0.48	8.53
		IV	3	6.0-6.5	6.17	—	—
		VI, IX	6	6.6-7.3	7.02	—	—
	Width talonid	II, III, V.	7	5.0-5.8	5.44	—	—
		VI	11	4.7-6.6	5.65	0.61	10.80
		IV	3	5.8-6.8	6.30	—	—
		VI, IX	7	6.2-7.3	6.90	—	—
M ₃ Length	II, III, V.	7	10.0-11.8	10.80	—	—	
	VI	10	9.7-11.1	10.40	0.50	4.80	
	IV	2	11.2-13.2	12.20	—	—	
	VI, IX	3	13.8-14.0	13.93	—	—	
	Width trigonid	II, III, V.	7	4.8-5.8	5.37	—	—
		VI	9	4.9-6.0	5.52	0.34	6.14
		IV	2	6.1-6.3	6.20	—	—
		VI, IX	3	7.0-7.3	7.17	—	—
	Width talonid	II, III, V.	7	4.5-5.6	5.07	—	—
		VI	10	4.4-5.5	5.05	0.45	8.91
		IV	2	5.9-6.1	6.00	—	—
		VI, IX	3	6.6-6.8	6.70	—	—

Hyracotherium vasacciense (Cope, 1872)

Plate IV, figures 4, 5, 7

MATERIAL. Lower faunal zone: Huerfano facies. (K) = referred by Kitts. *H. v. vasacciense*. Locality VI: AMNH nos. 2586, 17511(K), 17512(K), 17514(K), 17575(K), 17516(K), 17517(K), 17518(K), 17520(K), 55103(K), 55104(K), 55105(K), 55277, YPM 16455; Locality VIII: Kitts referred AMNH 55101, these specimens have not been studied other than to note the presence of this species in the quarry sample. Locality IX: AMNH 56531. Upper faunal zone: Huerfano facies. Locality I: AMNH 56529; Locality II: AMNH nos. 17446, 17447(K), 17449, 55180, 55181, 55183, YPM nos. 16479, 16481; Locality III: AMNH nos. 17021, 17448(K); Locality V: YPM nos. 16440, 16448. Upper faunal zone: Farisita facies, 1/2 mile east of Gardner Butte: AMNH 55185. *H. v. (?) venticolum*. Lower faunal zone, Farisita facies: Locality IV: AMNH nos. 17522, 55107, 56533, YPM 16436.

Hyracotherium vasacciense is present at localities I, II, III, IV, V, VI, VIII and IX and therefore occurs in both faunal levels. Horses are scarcer in the upper faunal zone, but those present closely resemble the lower zone sample. Probably through unfamiliarity with the Huerfano localities, Kitts (1956, p. 46) included two specimens, AMNH nos. 17447 and 17448, from the upper faunal zone in his analysis of the lower zone sample.

TABLE 28

Frequency distributions of talonid widths of M_3 of *Hyracotherium*
from the Huerfano formation

Width (in Millimeters)	VI, IX	Locality IV	II, III, V
4.4	1		
4.5			1
4.6			
4.7	2		
4.8	2		1
4.9			1
5.0			1
5.1	1		
5.2	1	<i>H. vasacciense vasacciense</i>	
5.3			1
5.4	1		
5.5	3		1
5.6			1
5.7			
5.8			
5.9			
6.0			
6.1		1	<i>H. vasacciense ?venticolum</i>
6.2			
6.3		1	
6.4			
6.5			
6.6	1		
6.7	1	<i>H. craspedotum</i>	
6.8			

Kitts placed the smaller Huerfano hyracothere in the subspecies *H. vasaccienne vasaccienne* on size criteria and the morphology of P³. He stated that the smaller horses were easily separable from the larger (*H. craspedotum*) on the basis of size; I found this true for most molar measurements, but I found some overlap in talonid widths of M₂ (see Table 28).

Twinning of the metaconid in molars, noted by Kitts (1956, p. 12) is common in Huerfano specimens of *H. vasaccienne*. Twinned metaconids are also present on DP₃₋₄ of AMNH 55185.

Without premolars for comparison, it is almost impossible to distinguish between the lower jaws of some smaller horses from Bridger, Huerfano and Wind River formations. Kitts (1957, p. 5) cites the shorter heel of M₃ as a basis for separation of *Orohippus* and *Hyracotherium*, but some specimens of M₃ from these formations are indistinguishable.

New data on tooth replacement of *Hyracotherium* is provided by AMNH 55185. The specimen consists of both jaws, several upper teeth and numerous skeletal fragments. The right jaw has DP₂₋₄ and M₁₋₃; M₃ not fully erupted. M₃ was in the process of eruption prior to the shedding of DP_{2, 3} or 4. AMNH 55185 is from low in the upper faunal zone, collected about 1/2 mile east of Gardner Butte (Farisita facies).

Four specimens of horses from locality IV (Farisita facies) are questionably assigned to *H. vasaccienne venticolum*. They are large for *H. v. vasaccienne* and small for *H. craspedotum*. These are the only horse specimens collected from locality IV and their presence suggests that, if they are correctly assigned to subspecies, *H. v. vasaccienne* and *H. v. venticolum* occupied different habitats in the same basin. AMNH 55185, mentioned above, also comes from the Farisita facies and is one of the smallest horses collected. It is, however, from several hundred feet higher in the upper faunal zone beds. If the locality IV horses are *H. v. venticolum*, then the known distribution of this subspecies is extended from the Wind River and Debeque formations to include the Farisita formation.

The measurements of teeth of specimens of *H. v. vasaccienne* from locality VI have bimodal distribution (see Table 28), best shown in talonid widths of M₃. Because the number of specimens in each group is about equal, I suggest that the difference is due to sexual dimorphism. The sample from the upper faunal zone is not sufficient to show this grouping.

FAMILY BRONTOTHERIIDAE

SUBFAMILY LAMBDOTHERIINAE

Lambdotherium popoagicum (Cope, 1880)

Plate IX, figure 4

MATERIAL. Locality IV: AMNH nos. 17530, 56534, YPM 16466; Locality VI: AMNH nos. 2688, 17526, 17527, 17528, 56535, 56536, 56537, 56541; Locality VIIa: AMNH nos. 55264, 55263, 56538.

Bonillas (1936, p. 141) placed all other described species of *Lambdotherium* in synonymy with *L. popoagicum*. The type specimen of *L. magnum* (Osborn), AMNH 17527, comes from locality VI of the Huerfano formation. Although that specimen is the largest lambdothere in the American Museum or the Peabody Museum collections, it is within the probable range of variability for the species *L. popoagicum*.

Most of the specimens of *Lambdotherium* from the Huerfano formation are jaw fragments. Statistics of measurements of lower teeth for both the Huerfano and Wind River specimens in the American Museum are listed in Table 29. The Huerfano sample of *Lambdotherium* resembles its counterpart in the Wind River formation more than any other pair of mammalian samples from these formations.

TABLE 29

Measurements (in Millimeters) of lower teeth of *Lambdaotherium popoagicum* from the Lost Cabin levels of the Huerfano and Wind River formations

Variate		Formation	N	OR	M	SD	V
P ₂	L	Huerfano	2	7.3-8.4	7.85	—	—
		Wind River	4	7.5-8.0	7.75	0.21	2.71
P ₂	W	Huerfano	2	4.1-5.0	4.65	—	—
		Wind River	4	4.1-4.7	4.43	0.28	6.33
P ₃	L	Huerfano	4	8.4-9.7	8.90	0.59	6.63
		Wind River	10	8.3-9.4	8.99	0.31	3.45
P ₃	W	Huerfano	4	5.4-6.3	5.85	0.47	8.03
		Wind River	10	5.3-6.6	5.82	0.46	7.90
P ₄	L	Huerfano	6	8.7-10.0	9.37	0.35	3.73
		Wind River	9	9.1-10.1	9.43	0.25	2.65
P ₄	W trigonid	Huerfano	6	6.3-7.2	6.72	0.33	4.91
		Wind River	9	6.3-7.3	6.76	0.31	4.59
P ₄	W talonid	Huerfano	6	6.5-7.5	7.02	0.33	4.70
		Wind River	9	6.6-7.7	7.04	0.44	6.25
M ₁	L	Huerfano	4	10.7-12.0	11.23	0.40	3.56
		Wind River	10	10.0-11.8	10.99	0.61	5.55
M ₁	W trigonid	Huerfano	5	7.2-8.2	7.84	0.38	4.85
		Wind River	10	6.9-8.5	7.67	0.35	4.56
M ₁	W talonid	Huerfano	5	7.5-8.7	8.12	0.55	6.77
		Wind River	10	7.3-8.5	7.95	0.37	4.65
M ₂	L	Huerfano	4	11.7-12.9	12.18	0.51	4.19
		Wind River	9	12.0-12.6	12.31	0.33	2.68
M ₂	W trigonid	Huerfano	4	8.6-9.6	9.15	0.44	4.81
		Wind River	10	7.8-9.5	8.81	0.38	4.31
M ₂	W talonid	Huerfano	6	7.5-9.6	8.85	0.76	8.59
		Wind River	9	8.2-9.5	8.89	0.41	4.61
M ₃	L	Huerfano	8	15.4-18.5	16.79	1.13	6.73
		Wind River	7	15.8-17.8	16.99	0.68	4.00
M ₃	W trigonid	Huerfano	9	8.2-10.1	8.94	0.63	7.05
		Wind River	7	8.3-9.6	9.03	0.43	4.76
M ₃	W talonid	Huerfano	7	7.0-9.5	8.18	0.79	9.66
		Wind River	8	7.5-9.2	8.23	0.55	6.69
M ₁₋₃	L	Huerfano	2	41.0-44.5	42.75	—	—
		Wind River	8	37.1-42.2	40.09	1.74	4.34

SUBFAMILY PALAEOSYOPSINAE

Palaeosyops fontinalis (Cope, 1882)

Plate I, figure 9, Plate VIII, figure 1, Plate IX, figures 1, 3

SYNONYM: *Eometarhinus huerfanensis* Osborn, 1919

MATERIAL. Locality I: AMNH nos. 17450, 17013, 17416, 56540, 17411, 17412, YPM 16462; Locality II: AMNH nos. 17417, 17425, YPM 16450; Locality V: AMNH nos. 55282, 17415, 17413, 17474; Locality No. 5 of R. C. Hills: YPM 16463; 1 mile south of Hausero's (Collected by R. C. Hills): YPM 16451; 1 mile a little southeast of Gardner Butte: YPM 16459.

The type specimen of *P. fontinalis* is a partial skull of a young animal with DP⁴-M². Another juvenile specimen, YPM 16451, has DP³⁻⁴, M¹, and DP₃₋₄, and is the only specimen of this species, known to me, that has lower and upper teeth associated. An excellent upper dentition, YPM 16450, consisting of left C-M³ and right P¹-M³, was collected by Peter Hilgendorf in 1958. Partial lower dentitions are commoner, but none are

well preserved. No lower dentition with both deciduous and permanent teeth is known to me. Therefore, lower jaws are referred to this species on size criteria and without comparison to YPM 16451.

The inclusion of *Eometarhinus huerfanensis* in *P. fontinalis* is based on comparison of the type of *E. huerfanensis*, AMNH 17412, with skulls of other palaeosyopsines. Osborn's reconstruction of the skull (1929, fig. 355) is, I think, misleading. The orientation of the nasals is speculative since no true contact remains. Restoration of the nasal position can be made to agree as well with palaeosyopsines such as AMNH 5104, type of *Limnohyops laevidens*, or with the type of *P. fontinalis*, AMNH 5107. The latter has very strongly arched nasals for a young animal. The nasal bones of palaeosyopsines are thin; they might have curved in dessication following death, as some bones do. The teeth of AMNH 17412 are poorly preserved but agree in outline and size with AMNH 17411 and YPM 16450. The maxilla and premaxilla of AMNH 17412 resemble AMNH 5104 closely. The apparently high maxillonasal contact is partly due to crushing. The "horn bosses" mentioned by Osborn (1929, p. 420) are apparently misinterpretations of the nasofrontal suture. No evidence for a hypocone on M_3 exists as that portion of the tooth is absent.

Future restudy of the Palaeosyopsinae will probably reduce the number of species and, perhaps, genera. *P. fontinalis* may eventually be considered a subspecies of *P. paludosus*, but it seems best to let the species stand until such time as detailed studies reveal its position.

Measurements of teeth of *P. fontinalis* from the Huerfano formation are given in Tables 30, 31.

TABLE 30
Measurements (in Millimeters) of lower teeth of *Palaeosyops fontinalis*
from the Huerfano formation

Variate		AMNH nos.					YPM nos.	
		17450	17417	17013	17416	55282	56540	16459 16463
P_2	L	—	—	—	—	—	—	16.2 —
	W	—	—	—	—	—	—	9.1 —
P_3	L	—	—	—	—	16.4	16.4	15.7 —
	W	—	—	—	—	9.6	8.8	9.2 —
P_4	L	—	—	—	15.8	17.7	—	15.8 —
	W trigonid	—	—	—	10.2	10.6	—	10.3 —
	W talonid	—	—	—	10.7	—	—	11.2 —
M_1	L	—	—	20.5	—	20.6	—	— —
	W trigonid	—	—	12.5	—	13.6	—	13.7 —
	W talonid	—	—	13.1	—	13.3	—	14.3 —
M_2	L	—	25.2	25.7	—	—	—	28.5 —
	W trigonid	—	16.2	16.0	—	—	—	17.2 —
	W talonid	—	17.1	16.6	—	16.5	—	— —
M_3	L	—	—	—	—	—	—	— 39.7
	W trigonid	—	—	—	—	18.0	—	— 19.1
	W talonid	16.5	—	—	—	16.4	—	— 18.4

GENUS *EOTITANOPS* Osborn, 1907

Eotitanops first occurs a few hundred feet above *Lambdaotherium* in both the Wind River and Huerfano formations. The species first described, *E. borealis* (Cope), is from the Lost Cabin level of the Wind River formation. Analysis of the *Eotitanops* material in the American Museum indicates that one population of this genus existed in upper Lost Cabin time in the Wind River basin. This species, for which the name *E. borealis* has priority, is also found in upper beds of the lower faunal zone of the Huerfano formation.

A second species of *Eotitanops*, *E. minimus*, is present in the upper beds of the Huer-

TABLE 31

Measurements (in Millimeters) of upper molars of *Palaeosyops fontinalis* from the Huerfano formation

Specimen	Buccal length	Lingual length	Anterior width	Posterior width	
			M ₁		
YPM nos.					
16451	—	19.0	23.6	—	
16450	23.4	19.5	24.0	23.9	
AMNH nos.					
17411	—	19.2	27.3	24.5	
5107*	26.6	20.5	29.0	25.9	Type
17413	26.9	21.6	27.3	—	
17425	—	21.0	28.3	—	
			M ₂		
YPM no.					
16450	29.5	22.3	30.5	28.4	
AMNH nos.					
17411	31.0	24.7	34.1	29.7	
17425	33.3	26.3	35.7	—	
			M ₃		
YPM no.				Width	
16450	31.0	21.00		29.0	
AMNH nos.					
17411	37.2	22.3		30.7	
17415	—	21.7		—	
17413	36.5	23.7		33.3	
17425	37.3	22.5		33.8	
17414	38.2	26.4		34.3	

* (From Osborn, 1929, Figure 270)

fano formation. *Palaeosyops fontinalis* occurs alongside *E. minimus*; the former is larger than *E. borealis* and the latter is smaller. I think that the two upper zone species are possible descendants of *E. borealis*. Morphologically, *E. borealis* resembles *P. fontinalis* more than it does *E. minimus*. *E. minimus* has the hypoconulid of M₃ relatively reduced, and therefore can be separated from *E. borealis* on morphological as well as size criteria.

As far as I know, *E. minimus* is found only in the upper faunal zone of the Huerfano formation.

Eotitanops borealis (Cope, 1880)

Plate IX, figure 2

One specimen, AMNH 17441, an M₂, from locality VII, is referable to *E. borealis*. Osborn (1919) referred this specimen to *E. brownianus*, but it is very similar to a referred specimen of *E. borealis*, AMNH 14890, (Osborn, 1929, p. 290). The type of *E. borealis* is an upper dentition and direct comparison is impossible.

Measurements (in Millimeters) of AMNH nos. 17441 and 14890

M ₃	Length	Width trigonid	Width talonid
17441	23.2	11.8	11.2
14890	23.1	—	11.3

Eotitanops minimus (Osborn, 1919)

Plate IX, figure 7

MATERIAL. AMNH nos. 17418, 17439 (type), 56539 and YPM 16439.

Eotitanops minimus is present in the upper faunal zone of the Huerfano formation, all four of the poorly preserved specimens coming from locality II. Osborn (1919, 1929) referred AMNH 17418 to *E. gregoryi*, but it is smaller than specimens from the Lost Cabin sample (Table 32).

TABLE 32

Measurements (in Millimeters) of second lower molars of *Eotitanops* from the Huerfano and Wind River formations

	Huerfano	Length	Width trigonid	Width talonid	
AMNH nos.	17439	14.5	9.1	9.3	Type <i>E. minimus</i>
	17418	15.7	10.2	10.9	
	56539	15.4	9.3	9.8	
YPM no.	16439	—	9.8	10.2	
Wind River					
AMNH nos.	14890	20.0	12.5	12.5	Type <i>E. gregoryi</i>
	14888	18.6	11.6	12.4	
	14889	17.0	10.6	10.2	
	14891	19.2	12.5	12.2	

FAMILY HELALETIDAE

Helaletes sp. cf. *H. nanus*

Plate IX, figures 5, 8

MATERIAL. Locality I: YPM 16464. Locality II: AMNH nos. 17503, 55262. Locality No. 5 of R. C. Hills: YPM 16457.

Several fragmentary specimens of *Helaletes*, collected from the upper faunal zone, resemble the Bridger species *H. nanus*. Radinsky (1963, p. 46) considers the upper Huerfano specimens as possible intermediates between *Heptodon* and *Helaletes*.

?Heptodon sp.

Three fragmentary specimens from locality IV are referable, with doubt, to *Heptodon*. These specimens are AMNH nos. 17523, 17524, 17563. They might also be *Helaletes*.

FAMILY HYRACHYIDAE

Hyrachyus modestus (Leidy, 1871)

Plate IX, figure 6

MATERIAL. Locality I: AMNH nos. 17014, 17436. Locality II: AMNH nos. 17440, 55261, field nos. 1952-277, -342, -407, -476. Locality V: AMNH 17442. Wood referred nos. 17014, 17436, 17440, 17442 to this species.

H. E. Wood (1934, p. 192, 196-7) referred the Huerfano specimens of *Hyrachyus* to *H. modestus*. As Wood noted, the material is fragmentary, and subsequent collections have not added significantly to knowledge of the species. At present the genus is known only from the upper faunal level. A complete lower molar series is provided by AMNH 17440 and DP₃₋₄ by AMNH 55261. AMNH 17436 has fragmentary limb and foot bones.

Measurements of *H. modestus* are listed in Table 33.

TABLE 33

Measurements (in Millimeters) of lower teeth of *Hyrachyus modestus* from the Huerfano formation

Specimen no.	AMNH 17442,	17440,	55261,	field no.
Locality:	V	II	II	1952-407
Variate				II
P ₂ L	8.4	—	—	—
W	5.3	—	—	—
P ₃ L	—	10.0	—	—
W	—	7.2	—	—
P ₄ L	—	11.9	—	—
W	—	8.8	—	—
DP ₃ L	—	—	13.8	—
W trigonid	—	—	6.7	—
W talonid	—	—	7.4	—
DP ₄ L	—	—	12.9	—
W trigonid	—	—	7.9	—
W talonid	—	—	8.3	—
M ₁ L	14.6	14.2	13.9	13.7
W trigonid	9.7	9.3	9.2	—
W talonid	9.9	—	9.5	—
M ₂	—	16.9	—	—
W trigonid	—	10.3	—	—
W talonid	—	11.3	—	—
M ₃ L	17.5	17.7	—	—
W trigonid	10.8	10.8	—	—
W talonid	10.3	10.2	—	—
M ₁₋₃ L	—	49.9	—	—

ORDER ARTIODACTYLA

FAMILY DICHOBUNIDAE

SUBFAMILY DIACODEXINAE (sensu Gazin, 1955)

GENUS *BUNOPHORUS* Sinclair, 1914

Bunophorus specimens occur in both the upper faunal zone, localities II and V, and the lower faunal zone, localities IV and VI, of the Huerfano formation. A single specimen was collected from the Farisita formation five miles north of Gardner Butte.

Gazin (1952, p. 72-73) states that distinction between *Bunophorus* and *Wasatchia* is difficult, and he draws attention to the nature of the wear of the cusps of upper teeth of *Bunophorus* noting the bunodonty and the circular areas of wear. The protocone, protoconule and metaconule of *Wasatchia* form a large worn crescent following wear (Sinclair, 1914, p. 262, fig. 6). In older specimens of *Bunophorus* the worn patches coalesce, the protocone and protoconule patches join first and then the metaconule patch joins. In extremely old specimens it may be impossible to tell the two genera apart. However, *Bunophorus* molars wear flat, while those of *Wasatchia* wear in a band, from front to back, across the center of the tooth. This comparison is drawn from one specimen of *Wasatchia*, AMNH 15673, the type of *Wasatchia dorseyana*, and four specimens of *Bunophorus* (given in order of increasing wear), YPM 16472, AMNH nos. 17485, 56524, and 17486. Admittedly, the discussion of *Wasatchia* is based on insufficient data.

The lower teeth of these genera are equally hard to distinguish. Gazin (1952, p. 72) notes that *Wasatchia* seems to have a paraconid and a hypoconulid, and inflated molars, but these characters can also be found in *Bunophorus*. Worn lower molars of *Wasatchia* have a raised trigonid whereas those of *Bunophorus* are flat. These wear differences cor-

relate with the upper teeth and indicate that the two genera probably had different chewing motions.

Bunophorus sp. cf. *B. macropternus* (Cope, 1882)

Plate X, figures 8, 10, 11

MATERIAL. Locality II: AMNH nos. 17485, 17486, 17487, 17488, 17489, 55204, 55252, 56524, 56525, 56527; YPM nos. 16472, 16475. Locality IV: AMNH 17553. Locality V: AMNH 55206. Locality—"East side William's Creek, five miles north of Gardner Butte." This set of exposures is in the Farisita formation. AMNH 17561.

Two species of *Bunophorus* have been described, *B. macropternus* (Cope, 1882, p. 179) and *B. etsagicus* (Cope, 1882, p. 189). The Huerfano specimens have a small basin on the heel of P_4 which *B. etsagicus* lacks. The P_4 of *B. macropternus* is not known, therefore designation of the Huerfano *Bunophorus* as *B. macropternus* is doubtful. AMNH 17561, from the Farisita facies, is noticeably smaller than Huerfano facies specimens.

The sample from the lower faunal zone is not sufficient to indicate any possible change between the populations of the two levels.

TABLE 34

Measurements (in Millimeters) and statistics of lower teeth of *Bunophorus* sp. cf. *B. macropternus* from the upper faunal zone of the Huerfano formation

Localities II and V.		N	OR	M	SD	V
Variate						
P ₄	L	2	7.7-8.1	7.90	—	—
	W	2	4.2-4.6	4.40	—	—
M ₁	L	7	6.5-7.3	6.90	0.26	3.77
	W trigonid	7	4.7-5.4	5.01	0.35	6.99
M ₂	W talonid	7	5.5-6.2	5.80	0.26	4.48
	L	6	7.3-8.0	7.77	0.25	3.22
	W trigonid	6	6.0-6.7	6.38	0.26	4.08
	W talonid	5	6.4-7.2	6.84	0.32	4.68
M ₃	L	4	8.0-10.3	9.38	0.99	10.55
	W trigonid	4	6.0-7.0	6.58	0.34	5.17
	W talonid	5	5.3-6.2	5.80	0.32	5.52
M ₁₋₃	L	4	23.6-25.8	24.70	0.90	3.64

Diacodexis chacensis (Cope, 1875)

Plate X, figure 4

One specimen, AMNH 17552, from locality VI is referable to *D. chacensis*. The specimen is small for *D. chacensis* but is within the limits of size stated by Sinclair (1914, p. 291). Measurements are quoted below.

Measurements (in Millimeters) of *D. chacensis*, AMNH 17552

P_4	Length	4.2
	Width	2.2
M_1	Length	3.8
	Width trigonid	2.6
	Width talonid	3.0
M_2	Length	4.2
	Width trigonid	3.0
	Width talonid	3.4

Diacodexis sp. cf. *D. secans* (Cope, 1881)

Plate X, figure 3

One specimen of *Diacodexis*, AMNH 17560, was collected from exposures in the Farisita formation one mile north of Gardner Butte. It resembles *Hexacodus* Gazin, but the hypoconulid of M_{1-2} is not situated as far behind the hypoconid as in *Hexacodus*. The entoconid of M_{1-2} bears accessory cuspules. The dimensions of M_1 are close to those mentioned by Gazin for a Knight specimen (Gazin, 1952, p. 71).

Measurements (in Millimeters) of *Diacodexis* sp. cf. *D. secans*, AMNH 17560

	P_4	M_1	M_2
Length	5.6	4.3	4.7
Width trigonid	3.2	3.2	3.9
Width talonid		3.5	4.2

SUBFAMILY HOMACODONTINAE (sensu Gazin, 1955)

Antiacodon pygmaeus huerfanensis new subspecies⁷

Plate X, figs. 1, 2

TYPE. AMNH 17490, fragments of both jaws with right P_4 - M_2 and Left M_{1-2} .

HYPODIGM. Type and AMNH nos. 17472, 55202, 17491, 55203, 56528.

HORIZON AND LOCALITY. Upper faunal zone, Huerfano formation, uppermost lower Eocene. Type and AMNH nos. 17472, 55202, 56528 from locality II, AMNH nos. 17491 and 55203 from locality III.

DIAGNOSIS. Slightly larger than *A. p. pygmaeus* from the Black's Fork member of the Bridger formation. P_4 similar to that of *Hexacodus*, with paraconid and metaconid imperfectly separated from protoconid.

DISCUSSION. The similarity of the fourth lower premolar of *A. p. huerfanensis* to *Hexacodus* adds support to Gazin's (1955, p. 11) hypothesis that *Hexacodus* might be the ancestor of *Antiacodon*.

The size of the individuals in the Huerfano sample is generally larger than that of the Bridger sample measured (collections at the American and Peabody Museums of Natural History), as listed in Table 35.

Measurements (in Millimeters) of AMNH 17490, type of *Antiacodon pygmaeus huerfanensis* new subspecies:

	P_4	M_1	M_2
Length	5.0	4.5	4.8
Width trigonid	2.9	3.1	3.7
Width talonid		3.5	4.1

⁷ Subspecific name in reference to Huerfano Park, Colorado and to the Huerfano formation.

TABLE 35

Measurements (in Millimeters) and statistics of *Antiacodon pygmaeus* from the Huerfano formation and from the Blacks Fork member of the Bridger formation

			Huerfano			
Variate		N	OR	M	SD	V
P ₄	L	2	5.0-5.4	5.20	—	—
	W	2	2.7-2.9	2.80	—	—
M ₁	L	1	—	4.5	—	—
	W trigonid	1	—	3.1	—	—
	W talonid	1	—	3.5	—	—
M ₂	L	4	4.8-5.4	5.10	0.26	5.10
	W trigonid	4	3.5-3.7	3.65	0.10	2.74
	W talonid	4	3.8-4.4	4.08	0.21	5.14
M ₃	L	3	5.0-5.5	5.27	—	—
	W trigonid	4	3.0-3.8	3.45	0.38	11.01
	W talonid	4	2.9-3.6	3.25	0.35	10.77
			Bridger			
		N	OR	M	SD	V
P ₄	L	2	4.8-4.9	4.85	—	—
	W	1	—	2.6	—	—
M ₁	L	7	4.2-4.6	4.41	0.26	5.90
	W trigonid	6	2.7-3.0	2.87	0.13	4.53
	W talonid	6	2.9-3.5	3.17	0.22	6.94
M ₂	L	7	4.5-4.8	4.64	0.12	2.59
	W trigonid	6	3.1-3.8	3.38	0.26	7.69
	W talonid	6	3.3-4.0	3.66	0.24	6.54
M ₃	L	5	5.2-5.5	5.32	0.13	2.44
	W trigonid	4	3.0-3.4	3.18	0.17	5.35
	W talonid	5	2.9-3.1	2.98	0.09	3.02

APPENDIX

STRATIGRAPHIC SECTIONS

Sections listed from south to north

SECTION 1. ARCHULETA DRAW

Starts in Sec. 1, T27S, R69W, and continues to Sec. 11, T27S, R69W.

Pediment:	<i>Thickness</i>
Huerfano formation (in part):	Feet
6. Mudstone, alternating red and brown, beds 5 to 15 feet thick, many concretions, some lenses of sandstone in valley walls, <i>Phenacodus vortmani</i> , <i>Hyracotherium vasacciense</i> , <i>Hyracotherium craspedotum</i> in lower 100 feet	385 feet
5. Covered	20.4
4. Sandstone, medium to fine grained, tan, poorly sorted, very poorly cemented, grains usually subangular; calcareous	28.0
3. Mudstone, sandy, red-brown and sandstone, grey-green in alternating beds, outcrop weathers tan, concretions	29.6
2. Claystone, dark red, silty, forms dark red layer in outcrops, some green claystone stringers	13.2
1. Mudstone, dark red-brown, sandy partly covered, concretions	53.9
Total measured thickness 530 feet	

Poison Canyon formation:

Sandstone, yellow, arkosic, locally conglomeratic, grains subangular to subrounded, poorly sorted, silt to small pebble size; mudballs; upper surface undulatory. Structurally conformable with unit 1 above.

SECTION 2. GARCIA CANYON

Starts in Sec. 34, T26S, R69W and continues into Sec. 3, T27S, R69W.

Pediment:	<i>Thickness</i>
Huerfano formation (in part):	feet
18. Mudstone, sandy, and sandstone, silty, tan, brown. some red layers ...	56.0
17. Mudstone, sandy, red-brown	5.6
16. Mudstone, sandy, light brown, color reddens near top, green stringers near top	21.4
15. Mudstone, red-brown, sandy, becomes browner and sandier at top, top tan; grades into sandstone laterally	16.8
14. Mudstone, sandy, brown, weathers tan, large concretions	9.1
13. Mudstone, red-brown, sandy, small concretions; light green siltstone layer 1.5 feet thick at 11.5 feet above base; unit becomes browner near top, <i>Hyracotherium vasacciense</i> , <i>Hyopsodus walcottianus</i> , crocodile, from near bottom of unit	30.0
12. Sandstone, coarse grained, conglomeratic, some conglomerate lenses, arkosic, cross-laminated, surface of unit 11 channeled; fragments of turtle, small siltstone lenses in sandstone. Color grey to green	47.8
11. Mudstone, dark brown, sandy	5.1
10. Sandstone, yellow to yellow-green, arkosic, conglomeratic, coarse	5.4
9. Sandstone, silty, light brown, some green mudstone lenses	3.6

Garcia Canyon Section (continued)

8. Sandstone, light brown, silty, becomes siltier and darker near top	14.0
7. Claystone, brown, sandy	8.6
6. Concretion layer, dense, calcareous	0.5
5. Covered	41.2
4. Sandstone, yellow-green, conglomeratic, coarse grained, poorly indurated	5.6
3. Sandstone, silty, brown, medium grained, arkosic jointed, weathers as large roundish boulders	5.6
2. Mudstone, brown, sandy; concretions, concretions white, sandy, large, bed weathers yellow in places	15.8
1. Sandstone, gray-green, arkosic, calcareous, grains angular and coarse . .	15.8

Total measured thickness 308 feet

Alluvium

SECTION 3. "FOSSIL CREEK"

In Sec. 12, T26S, R70W.

Pediment:

Huerfano formation (in part):

Thickness
feet

16. Mudstone, light green, sandy	5.6
15. Mudstone, red-brown, sandy; several concretion beds	25.6
14. Mudstone, green-brown, sandy, prominent 0.5 thick concretion layer 1 foot above base of unit	13.2
13. Mudstone, brown, sandy	11.2
12. Mudstone, green-brown, sandy	5.6
11. Mudstone, brown, sandy	7.4
10. Mudstone, green-brown, sandy	4.0
9. Mudstone, red-brown to brown, many concretions, some green claystone stringers; grades laterally into white sandstone. This is the bed that produced most of the fossils at locality II. All species reported on faunal list for locality II present in this bed	27.3
8. Sandstone, gray-green, silty, micaceous, arkosic, coarse to fine grained subangular grains, calcareous	17.8
7. Sandstone, yellow and white, coarse, silty micaceous, arkosic, yellower bands are conglomeratic; Farisita facies	28.0
6. Sandstone, gray-green, silty, arkosic, micaceous; upper part grades into unit 7, thin seams of gypsum cutting across bedding	9.0
5. Mudstone, sandy, red-brown, becomes greenish near top, <i>Notharctus nunienus</i> near base of unit	37.8
4. Sandstone, gray-green, silty, micaceous, arkosic; subangular, coarse to fine grained; Calcareous	18.3
3. Mudstone, dark red-brown, some green stringers, large concretions near top	21.5
2. Mudstone, brown, micaceous, sandy. Green concretionary layer 1 foot below top	16.2
1. Sandstone, green-gray, micaceous, arkosic, silty, poorly cemented, calcareous, grains angular	7.0

Total measured thickness 255 feet

Alluvium

SECTION 4. HUERFANO RIVER-MUDDY CREEK DIVIDE

Bottom of section in Sec. 14, T26S, R70W and continuing into Sec. 16 T26S, R.70 W. This is the area of locality I and the upper part of the type section of the Huerfano formation. The most persistent bed is unit 20 of this section which is probably the same bed as unit 63 of section 5. Unit 16 of section 3 may be the same bed. This is the only marker bed in the Huerfano formation. Most of the fossils from locality I come from below this bed but a few from Sec. 16 come from above it.

Pediment

Huerfano formation (in part):

	Thickness feet
31. Mudstone, red, silty	10+
30. Sandstone, yellow to tan, conglomeratic, arkosic, coarse, lenses of red mudstone	28.0
29. Sandstone, coarse to fine grained, tan	16.8
28. Mudstone, brown, red and green, sandy	31.2
27. Sandstone, yellow, coarse to fine grained, arkosic, layers peel off in weathering, cross-laminated	16.6
26. Mudstone, red-brown and green, sandy, concretionary	8.6
25. Concretion layer	0.5
24. Mudstone, brown	2.0
23. Concretion layer	0.7
22. Sandstone, tan, coarse, arkosic, cross-laminated, silty near top	10.1
21. Mudstone, red-brown, sandy	2.2
20. Mudstone, light green, <i>weathers white</i>	12.4
19. Mudstone, red-brown, <i>mottled with green</i>	5.1
18. Mudstone, red-brown, sandy, some green stringers, concretions	22.4
17. Sandstone, yellow to tan, poorly sorted, arkosic, silty, conglomeratic	4.0
16. Mudstone, dark red-brown, color changes at top to dark brown; concretionary	8.4
15. Mudstone, green, sandy	4.6
14. Mudstone, dark red-brown, concretionary	14.7
13. Mudstone, tan, sandy	15.7
12. Mudstone, brown, not concretionary	15.2
11. Sandstone, light green, arkosic, coarse, silty	3.0
10. Mudstone, tan, sandy, bone scrap	25.4
9. Concretion lens, brown calcareous mudstone	0.4
8. Mudstone, dark red-brown, sandy, concretionary, darkens at top	12.2
7. Mudstone, tan, sandy	18.7
6. Sandstone, tan, silty, poorly cemented, coarse to fine grained, arkosic ...	8.6
5. Mudstone, tan, sandy, concretionary	10.7
4. Sandstone, tan, silty, poorly cemented, coarse to fine grained, arkosic ...	5.6
3. Mudstone, tan, sandy, bone scrap	33.1
2. Sandstone, tan to green, coarse to fine grained, silty	5.0
1. Mudstone, red-brown, concretions	27.0

Total measured thickness 379 feet

Alluvium

SECTION 5. POISON CANYON-MUDDY CREEK

Base of section in Sec. 18 T26S, R70W; section measured eastward into Sec. 17 T26S, R70W. This is the type section of the Huerfano formation as designated by R. C. Hills (1891, p. 7). Although this section is truncated by a pediment (as most of the Huerfano formation sections are) it is almost fully exposed. This is the only locality in Huerfano Park where anything approaching a complete surface section can be measured.

Pediment

Huerfano formation (almost complete section):

	<i>Thickness</i> feet
66. Mudstone, grey and brown, with lenses of tan sandstone	50.4
65. Mudstone, red-brown, with tan sandstone lenses	25.4
64. Mudstone, red-brown and brown, sandy	109.7
63. Mudstone, green, silty, <i>weathers white</i> , grades laterally into coarse yellow conglomeratic arkosic sandstone	21.8
62. Mudstone, <i>mottled red and green</i>	9.6
61. Mudstone, brown, sandy	96.8
60. Mudstone, red-brown and brown, sandy	11.0
59. Sandstone, gray-green, coarse, conglomeratic	12.0
58. Mudstone, brown, sandy	6.0
57. Sandstone, gray-green, coarse, conglomeratic	12.0
56. Mudstone, red-brown and brown, sandy	424.0
55. Mudstone, brown and red-brown, sandy	129.0
54. Mudstone, red-brown and brown, coarse tan sandstone lenses	301.1
53. Mudstone, gray-green	9.0
52. Mudstone, red-brown and brown, lenses of tan sandstone	95.0
51. Sandstone, massive, yellow to tan, conglomeratic, poorly cemented	68.0
50. Mudstone, red and brown, sandy; bone scrap	40.0
49. Covered	108.0
48. Mudstone, tan, brown and red-brown, sandy	37.0
47. Sandstone, tan coarse, conglomeratic	7.6
46. Mudstone, red-brown	32.5
45. Sandstone, tan, silty	9.5
44. Mudstone, red-brown	35.0
43. Mudstone, brown and yellow, sandy, sandstone lenses	25.2
42. Mudstone, green and dark brown	14.3
41. Sandstone, tan to brown, coarse	9.0
40. Mudstone, red-brown	7.0
39. Sandstone, tan to brown, coarse conglomeratic	6.0
38. Mudstone, red-brown	30.3
37. Sandstone, coarse, tan arkosic	6.5
36. Mudstone, brown, sandy	19.0
35. Mudstone, green and red, some layers sandy	30.0
34. Mudstone, red-brown	16.0
33. Sandstone, tan, conglomeratic, arkosic	22.0
32. Mudstone, brown, sandy	15.0
31. Sandstone, tan, conglomeratic	6.3
30. Mudstone, brown, sandy	35.3
29. Sandstone, green, arkosic, coarse	8.8
28. Mudstone, red-brown	45.7
27. Mudstone, brown, sandy, some beds sandier	90.0
26. Sandstone, tan, coarse, conglomeratic, arkosic	7.0
25. Mudstone, red-brown	19.0
24. Sandstone, tan, coarse	3.0
23. Mudstone, red-brown	7.5

Poison Canyon-Muddy Creek Section (continued)

22. Mudstone, brown, sandy	39.5
21. Sandstone, tan, conglomeratic	59.0
20. Mudstone, brown, sandy	5.0
19. Sandstone, coarse, tan, arkosic	13.0
18. Mudstone, red-brown	42.0
17. Sandstone, brown, coarse, poorly indurated	7.0
16. Mudstone, brown, sandy	4.3
15. Sandstone, tan, coarse, arkosic	5.7
14. Conglomerate, yellow to tan, boulders of gneiss, schist, granite up to 0.9	14.8
13. Mudstone, red-brown	74.0
12. Mudstone, brown, sandy	11.8
11. Mudstone, red-brown	69.0
10. Covered	220.0
9. Mudstone, brown, sandy	24.0
8. Sandstone, tan, coarse, arkosic	1.3
7. Mudstone, brown, sandy	3.8
6. Mudstone, green, sandy	1.8
5. Mudstone, brown, sandy, with large concretions	28.0
4. Sandstone, green, silty	2.4
3. Mudstone, brown, sandy	14.3
2. Mudstone, red-brown	5.1
1. Mudstone, brown, sandy	16.0

Total measured thickness 2,735 feet

Poison Canyon formation:

Sandstone, yellow-cross-laminated, arkosic conglomeratic; contact with overlying Huerfano formation structurally conformable.

SECTION 6. BLACK MOUNTAIN

Base of section in Sec. 35, T25S, R71W and continues into Sec. 25, T25S, R71W.

Covered

Huerfano formation (in part):

	<i>Thickness</i> feet
45. Mudstone, dark gray-green, weathers white, plastic, sandy	4.0
44. Mudstone, red-brown, sandy	11.4
43. Conglomerate, brownish-pink, arkosic, micaceous	13.9
42. Mudstone, red	0.5
41. Sandstone, pink, silty, arkosic	5.7
40. Mudstone, red-brown, sandy	58.0
39. Sandstone, pink, arkosic, silty	2.0
38. Mudstone, red-brown, sandy	34.2
37. Mudstone, red-brown; 1-foot thick sandstone bed at 51.3 feet; unit becomes sandier towards top	85.5
36. Conglomerate, brownish gray, sandy	5.0
35. Mudstone, red-brown; beds of brown sandy mudstone with green stringers, much of unit covered	256.3
34. Sandstone, conglomeratic, arkosic, with thin lenses of silty sandstone ...	34.2
33. Mudstone, red-brown	13.3

Black Mountain Section (continued)

32. Mudstone and claystone, yellow and gray, pebbly, plastic	7.8
31. Sandstone, white, silty, arkosic, conglomeratic; laterally grades into yellow conglomerate	25.8
30. Mudstone, red-brown, sandy	77.1
29. Mudstone, gray, plastic, sandy	5.0
28. Mudstone, red-brown	64.2
27. Sandstone, pink, silty, arkosic, conglomeratic; lenses of red mudstone ...	15.5
Huerfano formation?	
26. Sandstone, yellow-brown (limonite color), poorly indurated	76.6
25. Mudstone, yellow-brown to gray, fissile, plastic	21.8
24. Sandstone, yellow to white, conglomeratic	5.0
23. Clay and sandy clay, yellow to green, plastic, sticky (?bentonite)	13.4
22. Sandstone, light gray, coarse arkosic, poorly indurated	5.0
21. Mudstone, blue-gray (gun-metal color), bed of grey mudstone at 90 feet .	117.8
20. Sandstone, dark brown to gray, conglomeratic, arkosic, dark cement	1.3
19. Mudstone, red-brown, sandy, fissile	19.0
18. Sandstone, brown and yellow, silty, arkosic	5.8
17. Mudstone, alternating 1 foot thick layers of red and grey	7.5
16. Sandstone, white, silty, arkosic, conglomeratic, micaceous, coarse, forms a bold white outcrop with prominent knobs	19.6
15. Sandstone, yellow-brown, conglomeratic, "limonite" cement; with pisolitic "limonite" layer	1.0
14. Mudstone, blue-grey (gun-metal color)	11.3
13. Mudstone, red-brown and yellow, sandy	2.5
12. Sandstone, gray to tan, coarse, arkosic, conglomeratic; laterally grades into micaceous siltstone	18.0
11. Mudstone, red and green, fissile	8.6
10. Mudstone, red, green and gray, sandy, stringers of "limonite"	12.9
9. Sandstone, yellow to tan to gray, arkosic, micaceous, poorly indurated ..	23.0
8. Mudstone, red and green, with stringers of "limonite," grades laterally into gray silty sandstone	16.0
7. Sandstone, tan to brown, conglomeratic, arkosic, weathers easily	9.3
6. Mudstone, red, yellow and gray, micaceous, sandy, arkosic	9.8
Poison Canyon formation?	
5. Sandstone, yellow, silty, micaceous	1.7
4. Sandstone, yellow, silty, arkosic, coarse, cross-laminated	1.0
3. Clay, gray, plastic	5.0
2. Sandstone, light green to tan, silty, laterally grades into brown sandstone with less silt	21.0
1. Sandstone, yellow-brown, conglomeratic, coarse, arkosic, "limonite" nodules; weathers light yellow	22.0

Total measured thickness 1175 feet

Poison Canyon formation

SECTION 7. BLACK MOUNTAIN

Base of section Sec. 36 T25S. R71W and continues to Sec. 25, T25S, R71W.

Farisita formation:

Conglomerate, yellow, sandy; boulders up to 3 feet in diameter, boulders of highly weathered schist, arkose; Channels into Huerfano formation; angular unconformity.

Huerfano formation (in part):

	<i>Thickness</i> feet
30. Sandstone, red and white, coarse, silty; grades into red and white sandy mudstone near top	3.0
29. Conglomerate; sandy	5.7
28. Mudstone, red and green	5.7
27. Sandstone, tan to yellow, massive, conglomeratic, boulders of biotite schist, lower 3 feet laminated, upper part cross-laminated. A prominent cliff former	20.1
26. Sandstone, brown, silty, conglomeratic	64.7
25. Sandstone, green to brown, coarse, arkosic	5.7
24. Sandstone, brown, silty; top of first sandstone bed at 17.1 feet; some green silty lenses; dark 0.5 foot sandstone bed at 28.5 feet	74.1
23. Mudstone, gray-green, sandy, <i>weathers white</i>	29.5
22. Mudstone, red-brown, sandy, <i>upper few feet mottled red and green</i> . May be same bed as unit 19 in section 4 and unit 62 in section 5	14.4
21. Sandstone, pink, arkosic, conglomeratic	7.0
20. Mudstone, red-brown, some pink sandstone lenses and gray-green silty sandstone lenses	79.8
19. Mudstone, gray-green	2.5
18. Mudstone, red, silty. Tooth of <i>Didymictis vanceleveii</i> at 39.9 feet	71.4
17. Mudstone, red and green, sandy, weathers olive green	5.0
16. Mudstone, brown, sandy	79.8
15. Sandstone, yellow to brown, conglomeratic. Boulders derived from Sangre de Cristo formation; boulders up to 1.3 feet in diameter. Grades laterally into green-white sandstones	9.7
14. Mudstone, red-brown, sandy, with green nodules	5.7
13. Mudstone, red-brown and green, sandy; weathers red-brown and grades laterally into pink arkosic sandstone	31.5
12. Mudstone, red-brown, sandy, some green-grey sandstone lenses	51.3
11. Conglomerate, boulders of granite, schist, and arkose	19.1
10. Mudstone, brown, sandy, pebbly	5.7
9. Sandstone, red to light gray, boulder conglomerate at top	17.1
8. Mudstone, grey-green	13.2
7. Mudstone, red-brown, sandy with lenses of green silty sandstone	15.3
6. Sandstone, white, poorly indurated, pebbly	11.2
5. Mudstone, brown, sandy	6.4
4. Sandstone, yellow to tan, silty, conglomeratic lenses; lenses of red silty sandstone give outcrop a pink color	3.5
3. Mudstone, red with green stringers	7.9
2. Conglomerate, pink	7.0
1. Mudstone, red to purple, stringers of green calcareous siltstone	21.5

Total measured thickness 694 feet

Covered

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PLATE I

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- Figure 2. *Palaeictops bicuspis*, AMNH 55271, at left M_3 from locality VIII. $\times 10$. Unintentionally mounted in reverse.
- Figure 3. *Scenopagus priscus*, AMNH 55156, fragment of left jaw with P_4 - M_1 from locality III. $\times 10$.
- Figures 4, 5. ?*Metacheiromys* sp., AMNH 18666, right astragalus from 1 mile north of Gardner Butte, Farisita formation, ventral and dorsal views. $\times 2$.
- Figure 6. *Bathyopsis fissidens*, AMNH 17438, a left P_2 from locality III. $\times 2$.
- Figure 7. *Peratherium* sp., AMNH field 1952-328, fragment of left jaw with M_3 from locality II.
- Figure 8. *Coryphodon* sp., AMNH 56543, a left P_3 from locality II. $\times 0.8$.
- Figure 9. *Palaeosyops fontinalis*, YPM 16463, right M_3 from locality 5 of R. C. Hills. $\times 2$.



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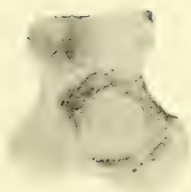
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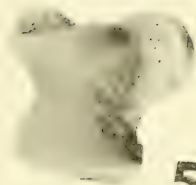
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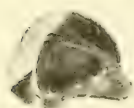
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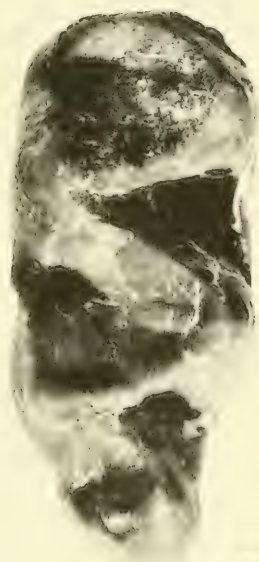
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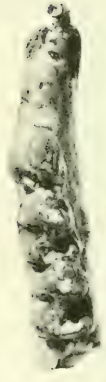
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PLATE II

All figures stereopairs

Figure 1. *Absarokius noctivagus nocerae*, new subspecies, Type, AMNH 55215, fragment of left jaw with P_2 - M_3 from locality II. $\times 4.8$.

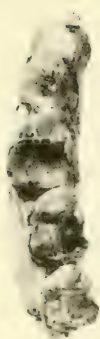
Figure 2. *Loveina zephyri*, AMNH 17554, fragment of left jaw with P_4 - M_2 from locality VI. $\times 4.8$.

Figure 3. *Nyctitherium* sp. cf. *N. velox*. AMNH 55151, fragment of left jaw with M_{2-3} from locality III. $\times 10$.

PLATE III

All figures stereopairs

- Figure 1. *Huerfanius rutherfordi*, new genus, new species, type, AMNH 55216, fragment of left jaw with P_3 - M_2 from locality II. $\times 4.8$.
- Figure 2. *Phenacolemur jepseni simpsoni*, new subspecies, type, AMNH 2680, fragment of right jaw with P_4 - M_1 from the lower faunal zone, probably locality VI. $\times 4.8$.
- Figure 3. *Shoshonius cooperi*, AMNH 55153, fragment of right jaw with M_{1-3} from locality II. $\times 4.8$.
- Figure 4. *Scenopagus edenensis*, AMNH 17483, fragment of right jaw with P_4 - M_3 from locality III. $\times 4.8$.
- Figure 5. *Scenopagus edenensis*, type, AMNH 55685, right M_{1-3} , from Morrow Creek Member of Green River formation. $\times 4.8$. Unintentionally mounted in reverse.



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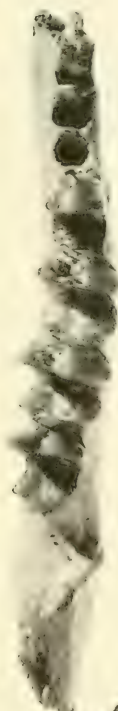
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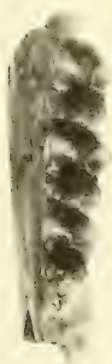
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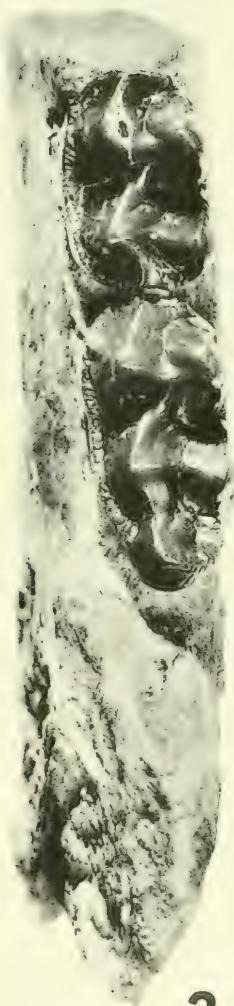
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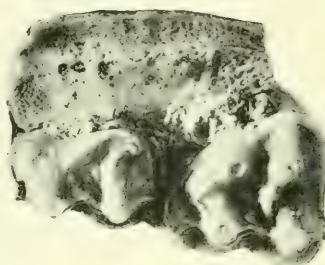
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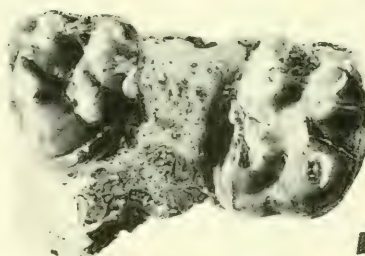
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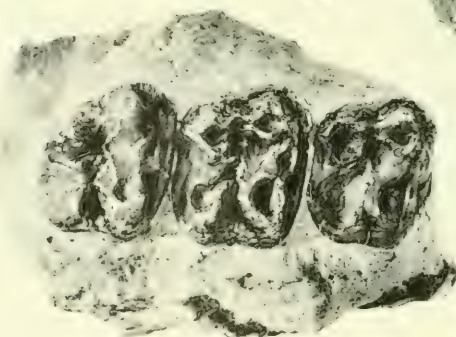
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PLATE IV

- Figure 1. *Cynodontomys scottianus*, YPM 16468, fragment of right jaw with P_4 - M_1 from locality IV. $\times 1.6$.
- Figure 2. *Cynodontomys knightensis*, AMNH 55225, fragment of right jaw with I, P_4 - M_3 from locality II. $\times 1.6$.
- Figure 3. *Hyracotherium craspedotum*, AMNH 17513, fragment of left jaw with M_{2-3} from locality VI. $\times 3.0$.
- Figure 4. *Hyracotherium vasacciense ?venticulum*, YPM 16436, fragment of right maxilla with DP^{2-3} from locality IV. $\times 3.0$.
- Figure 5. *Hyracotherium vasacciense vasacciense*, YPM 16481, fragment of left maxilla with P^4 - M^1 from locality II. $\times 3.0$.
- Figure 6. *Microsyops lundeliusi*, YPM 16482, fragment of mandible with right P_2 - M_3 from locality II. $\times 1.6$.
- Figure 7. *Hyracotherium vasacciense vasacciense*, YPM 16455, fragment of right maxilla with M^{1-3} from locality VI. $\times 3$.

PLATE V

- Figure 1. *Stylinodon* sp., YPM 14616, canine tooth from "South of Hausero's Ranch." $\times 0.8$.
- Figure 2. *Vulpavus asiaticus*, AMNH 56508, fragment of right jaw with M_2 from locality II. $\times 1.6$.
- Figure 3. *Viverravus gracilis*, YPM 16467, fragment of left jaw with M_{1-2} from locality IV. $\times 1.6$.
- Figure 4. *Uintacyon* sp. cf. *U. asodes*, AMNH 17434, fragment of right jaw with P_4-M_1 from locality VI. $\times 1.6$.
- Figure 5. ?*Miacis* sp. AMNH 56544, fragment of left jaw with M_2 from locality II. $\times 1.6$.
- Figures 6, 7. *Oxyaena* sp. cf. *O. lupina*, AMNH 55298 from locality VI; fig. 6 right M^1 , fig. 7 right M_2 . $\times 0.8$.
- Figure 8. *Esthonyx acutidens*, AMNH 17531, fragment of left jaw with P_3-M_3 from locality VI. $\times 0.8$.
- Figure 9. ?*Oödictes* sp., AMNH 2681, fragment of left jaw with P_1-M_2 from lower faunal zone, probably locality VI. $\times 1.6$.
- Figure 10. *Miacis parvivorus*, AMNH 17435, fragment of left maxilla with M^2 from locality II. $\times 1.6$.
- Figure 11. *Oödictes herpestoides*, AMNH 56504, fragment of left maxilla with parts of P^3-M^2 from locality III. $\times 1.6$.
- Figure 12. *Viverravus sicarius*, AMNH 56511, fragment of right maxilla with parts of P^2-M^1 from locality II. $\times 1.6$.



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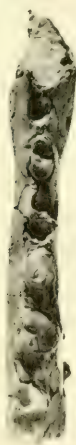
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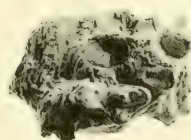
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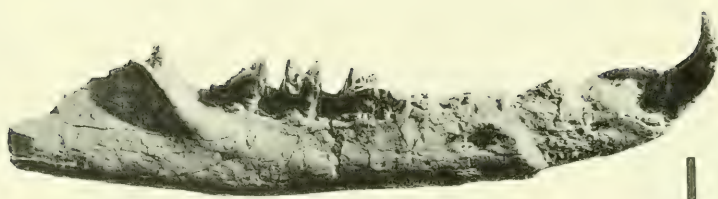
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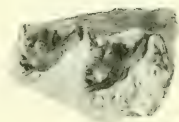
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PLATE VI

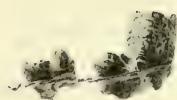
- Figure 1. *Sinopa* sp. cf. *S. strenua*, AMNH 17421, right jaw with M_{1-3} from locality II. $\times 0.8$.
- Figure 2. *Patriofelis ulta*, AMNH 17017 (Type of *P. compressa*), left jaw with C, P_2 - M_2 from locality III. $\times 0.8$.
- Figure 3. *Mesonyx obtusidens*, AMNH 55272, fragment of right maxilla with P^4 - M^2 from locality II. $\times 0.8$.
- Figure 4. *Mesonyx obtusidens*, AMNH 17423, fragment of left jaw with parts of P_2 - M_3 from locality III. $\times 0.8$.
- Figure 5. *Sinopa* sp. cf. *S. strenua*, AMNH 17421, fragment of left maxilla with M^{1-2} from locality II. $\times 0.8$.

PLATE VII

- Figures 1, 7. *Didymictis ?protenus*, YPM 16458, fragment of right jaw with M_{1-2} from locality VIII, occlusal and buccal views. $\times 0.8$.
- Figures 2, 4. *Didymictis vancleveae*, type, AMNH 17424, fragment of left jaw with P_2 - M_2 from locality I, occlusal and buccal views. $\times 0.8$.
- Figures 3, 5. *Didymictis altidens*, AMNH 2677, right M_{1-2} from the lower faunal zone, probably locality VI, occlusal and buccal views. $\times 0.8$.
- Figure 6. *Didymictis vancleveae*, new species, AMNH 17030, fragment of skull with left P^4 - M^2 and right M^{1-2} from locality I, Palatal view. $\times 0.8$.



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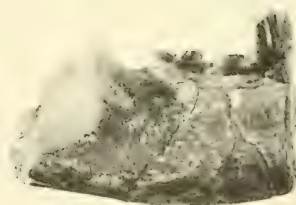
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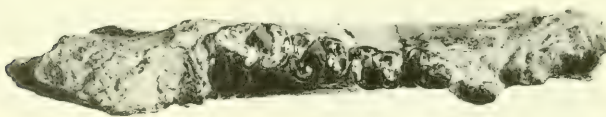
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PLATE VIII

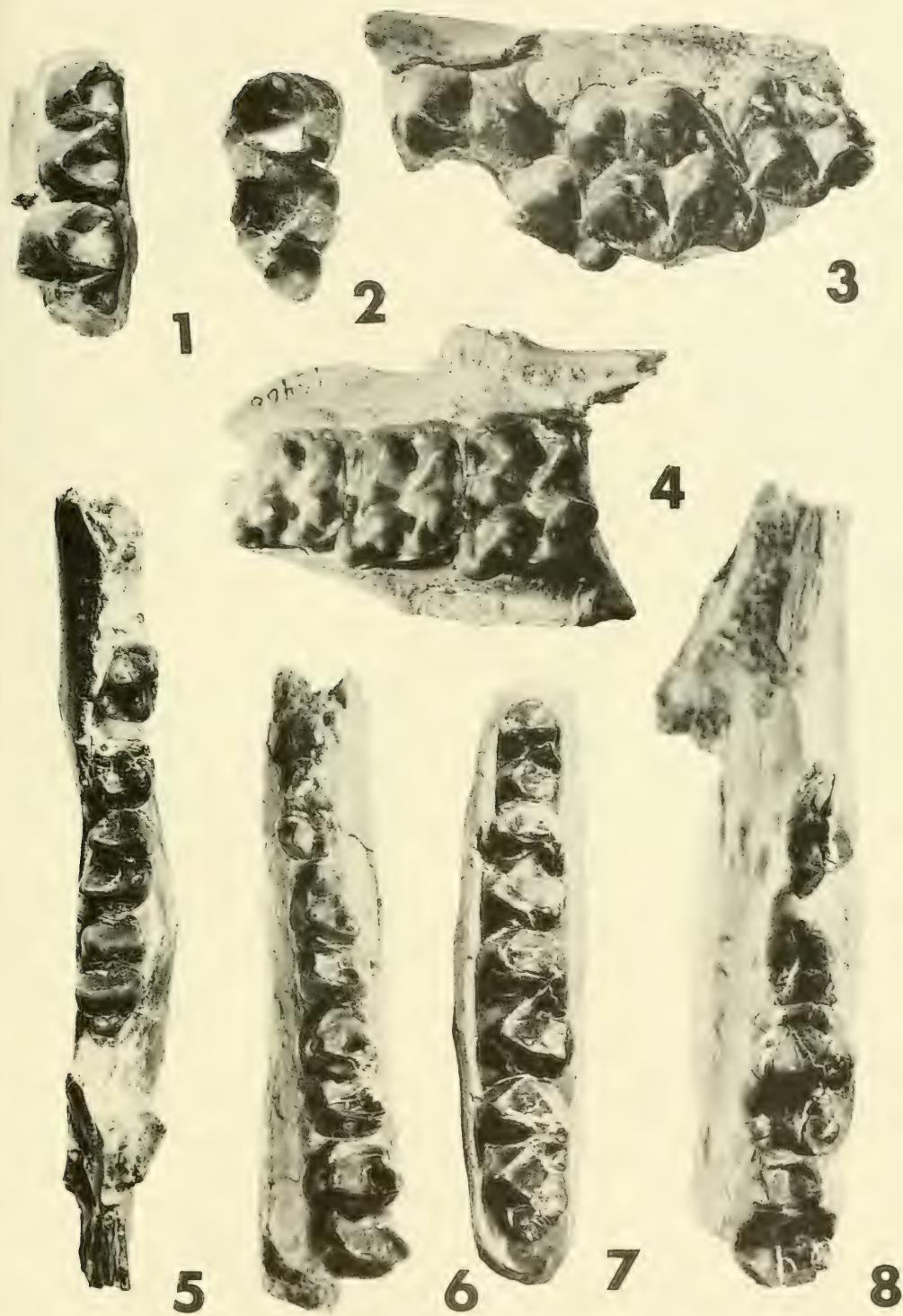
Figure 1. *Palaeosyops fontinalis*, YPM 16450, fragment of left maxilla with C-M³ from locality II. $\times 0.8$.

Figure 2. *Trogosus grangeri*, YPM 16449, fragment of right jaw with I₂, P₃-M₃ from locality II. $\times 0.8$.

Figure 3. *Notharctus nunienus*, AMNH 55224, fragment of right jaw with P₃-M₅ from locality VI. $\times 1.6$.

PLATE IX

- Figure 1. *Palaeosyops fontinalis*, YPM 16451, fragment of left jaw with DP_3 and part of DP_4 from "South of Hausero's Ranch." $\times 1.5$.
- Figure 2. *Eotitanops borealis*, AMNH 17441, right M_3 from locality VII. $\times 1.5$.
- Figure 3. *Palaeosyops fontinalis*, YPM 16451, fragment of left maxilla with DP^{3-4} and part of M^1 from "South of Hausero's Ranch." $\times 1.5$.
- Figure 4. *Lambdaotherium popoagicum*, YPM 16466, fragment of right maxilla with M^{1-3} from locality IV. $\times 1.5$.
- Figure 5. *Helalestes nanus*, type, YPM 11807, fragment of right jaw with P_4 - M_3 from the Bridger formation. $\times 2.0$.
- Figure 6. *Hyrachyus modestus*, AMNH 55261, fragment of left jaw with DP_{3-4} , M_1 from locality II. $\times 2.0$.
- Figure 7. *Eotitanops minimus*, type, AMNH 17439, left P_4 - M_3 from locality II. $\times 2.0$.
- Figure 8. *Helalestes* sp. cf. *H. nanus*, YPM 16457, fragment of right jaw with parts of P_2 - M_1 from locality 5 of R. C. Hills.





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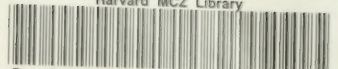
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PLATE X

Figures 1-4 are stereopairs

- Figure 1. *Antiacodon pygmaeus huerfanensis*, new subspecies, AMNH 55202, fragment of left jaw with M_{2-3} from locality II. $\times 1.6$.
- Figure 2. *Antiacodon pygmaeus huerfanensis*, new subspecies, type, AMNH 17490, fragment of right jaw with P_4 - M_2 from locality II. $\times 1.6$.
- Figure 3. *Diacodexis* sp. cf. *D. secans*, AMNH 17560, fragment of right jaw with P_4 - M_2 from Farisita formation, 1 mile north of Gardner Butte. $\times 1.6$.
- Figure 4. *Diacodexis* sp. cf. *D. chacensis*, AMNH 17552, fragment of left jaw with P_4 - M_2 from locality VI. $\times 1.6$.
- Figure 5. *Hyopsodus wortmani*, YPM 14612, fragment of left jaw with M_{1-3} from locality I. $\times 1.6$.
- Figure 6. *Phenacodus vortmani*, AMNH 55230, fragment of right jaw with P_3 - M_3 from locality IX. $\times 0.8$.
- Figure 7. *Hyopsodus walcottianus*, YPM 16446, fragment of left jaw with M_{1-2} from locality IV. $\times 1.6$.
- Figure 8. *Bunophorus macropternus*, YPM 16475, fragment of right jaw with P_4 - M_3 from locality II. $\times 0.8$.
- Figure 9. *Hyopsodus paulus*, YPM 16435, fragment of right jaw with M_2 from locality III. $\times 1.6$.
- Figure 10. *Bunophorus macropternus*, YPM 16472, fragment of left maxilla with M^{1-2} from locality II. $\times 0.8$.
- Figure 11. *Bunophorus* sp. cf. *B. macropternus*, AMNH 17561, fragment of left jaw with M_{2-3} from Farisita formation, east side of Williams Creek, 5 miles north of Gardner Butte. $\times 0.8$.

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